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(Photographed about 1938)

E. G. Goldman

JOURNAL OF MAMMALOGY

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EDWARD ALPHONSO GOLDMAN: 1873–1946

BY STANLEY P. YOUNG

It has been said that "It is as natural to die as to be born, and to the little infant, perhaps one is as painful as the other. It is worthy the observance, that there is no passion in the mind of man so weak, but it makes and masters the fear of death, and therefore death is no such terrible enemy when a man hath so many attendants about him that can win the combat of him. Revenge triumphs over death, love slights it, honor aspireth to it, grief flieth to it, fear preoccupieth it, pity provoketh it.

"He that dies in an earnest pursuit is like one wounded in hot blood, who, for the time, scarce feels the hurt,. . . Death hath this also that it openeth the gate to good fame."

So died E. A. Goldman.

Again, it is recorded that "Circumstances play odd tricks with history. Because a general didn't follow orders, Napoleon took the ten-count at Waterloo. As Vice-President, Teddy Roosevelt was washed up in politics, but the shooting of President McKinley booted the Big Stick into the rider's seat. When an opera conductor in Buenos Aires got a tummy ache while a packed house waited for the curtain to rise, the frantic impresario threw in the cellist as a dummy director and discovered the greatest conductor of modern times, Toscanini." Because a black-bearded man rode out of Death Valley in a buckboard in 1892, a budding horticuturist blossomed into one of the country's best naturalists.

This obituary might well be titled the "Broken Singletree" for 'twas the requested repair of this instrument of draught that was to shape Goldman's destiny for more than half a century. More on this later.

Edward Alphonso Goldman, the son of Jacob H. and Laura C. Goltman, was born at Mount Carroll, Illinois, on July 7, 1873. His parents of French-German extraction were former farming Pennsylvanians, who in the early eighties gave up the Mount Carroll holdings seeking greener pastures. Driving 300 head of cattle overland, the Goltman family headed for Falls city, Nebraska. Here, shortly after the Goltmans had settled, a horde of grasshoppers took over the country, resulting in the loss of practically all of the livestock from starvation. While domiciled at this point, Goldman's father changed the spelling of his name Goltman to Goldman, because it is said "Dad was tired of trying to correct his

neighbors (on the spelling) and also on the pronunciation." Nebraska, however, in the opinion of the elder Goldman, also had its other drawbacks similar to his experiences in Pennsylvania and Illinois, so, once again, the urge to move resulted in the Goldmans settling in Tulare County, California, in 1888, Edward Goldman then being 15 years old, and only a few years before "Broken Singletree" was to change his entire life.

Goldman, in later years, told me his interest in natural history undoubtedly stemmed from his father, who was an amateur nature student. His urge to collect was apparent while on the Nebraska ranch, for during his stay here he was using an old single-barreled muzzle-loading shotgun with good results in collecting bird and mammal specimens. Naturally, this continued after the move to California.

Duties of "boy around the ranch" kept young Goldman occupied until at the age of 17 he accepted a job as foreman in a vineyard near Fresno, California, at $56 a month, with board included. It was while here that the "Broken Singletree" entered the scene, and with it a young naturalist, Edward William Nelson (1855–1934) with whom Goldman's name was long to be linked as the collectors *par excellence* in the team of Nelson and Goldman. Nelson looked upon Goldman, in later years, as a father would a son, the result of over forty years of close association. It was a deep friendship, as only such friendship between men is rarely observed. As Goldman himself put it, it was "a friendship and close association with Nelson that was to endure until the latter's death."

In the early 1890's at the conclusion of the Bureau of Biological Survey's expedition to Death Valley, California, the famous personnel comprising it—Dr. C. Hart Merriam, Dr. A. K. Fisher, Dr. T. S. Palmer, Dr. Frederick C. Coville, Frank Stephens, Basil Hicks Dutcher, Frederick Funston (later Brigadier General, U. S. A.) and Nelson, who was to become the third Chief of that Bureau—dispersed in Visalia, Tulare County. Some went on to other temporary field assignments as planned by the late C. Hart Merriam, then leader of the expedition and Chief of the Bureau. Nelson was requested to travel southward by buckboard through the San Joaquin Valley, and it was while enroute that he experienced trouble with a broken singletree. Approaching the Goldman ranch near Alila (now Earlimart), California, with a view of having the "tree" repaired Nelson struck up an acquaintance with father Jacob. It was not long until their mutual interests in natural history were discovered, and the fact that Nelson was looking for an assistant, soon caused the father to comment: "Maybe my son Ed. would do."

"Where is he", asked Nelson.

"In a fruit-packing plant at Fresno," replied the father.

Not long thereafter the senior Goldman brought son Ed. from Fresno to the Goldman's ranch for Nelson's "size-up." Result, Edward Alphonso Goldman, a boy of eighteen, left the Goldman's holdings on October 10, 1891, as personal assistant to Nelson, then 36, with a salary of $30 a month plus board. Nelson paid this out of his own salary, which was then $1,800 per annum.

To this day these two budding naturalists, in their traveling outfit of a buck-

board and its mended "singletree," plus two 42-pound grizzly bear traps dangling from each side, still conjure up a comical picture in the minds of their associates, still living, who knew them so well.

The first field trip was of short duration for the two men in that it was terminated on January 4, 1892, after they had collected in the southern end of the San Joaquin Valley to within 8 miles of Tejon Pass, and onward to the head of San Emigdio Canyon, thence northward to San Luis Obispo. From the last point they went northward to the San Simeon and adjacent mountains, then southward along the coast, where they collected sea birds, to Santa Paula. Apparently, during this time Goldman was being "tried out" and proved "satisfactory."

Now follows Nelson's orders from C. Hart Merriam, authorizing him to journey into western Mexico, on what was purported to be a three month collecting assignment. Taking Goldman with him, Nelson sailed on the steamer "Acapulco", from San Pedro for Manzanillo, Colima, where they landed on January 24, 1892. From the time of sailing until March 1, 1892, Goldman was without salary, receiving only his board for the additional "field experience." On March 1, 1892, Goldman through Nelson's appeals to Merriam had his first Federal appointment, temporary field assistant with the magnificent salary of $75 a month, plus "you pay your own expenses." And what was to be a three month stay in Mexico turned out to be four years, when Goldman was "permitted to come home." In the interim Goldman received new appointments which made his official status more satisfactory and secure with an occasional raise in the way of promotions for excellent field work. All in all, more than fourteen years were spent by him in the southern sister republic. His journeys when mapped completely spider-web Mexico, and with the exception of northern Coahuila, he and Nelson together, or Goldman on his own, traveled, collected, and studied Mexican fauna in every nook and cranny of Mexico. They visited every State and territory in Mexico, and in some instances had crossed and recrossed them several times. Their combined mammal collection from October 10, 1891, until Nelson's death in 1934, totaled 22,756 specimens, and since that time Goldman added another 1,268. His last specimen was collected on April 4, 1946, a pocket gopher from Florida.

From the time of Goldman's official appointment on March 1, 1892, as assistant field agent, he continued to carry on biological investigations in the field service which were interrupted by other assignments as the occasion demanded. These took him over nearly all parts of the United States, where his opinions were eagerly sought in the field of game management, particularly on the deer problems of the various States. During the construction of the Panama Canal he worked on a faunal survey, which covered the Isthmus, a joint work sponsored by the Smithsonian Institution, and the War and Agriculture departments. Results of this work were published under the title "Mammals of Panama," by the Smithsonian Institution in 1920. For six years he was in charge of the Survey's Division of Biological Investigations, and for three years in charge of the Big Game and Bird Reservations. One and one-half years were spent as sanitary officer with the rank of Major, in charge of rodent control work with the American

Expeditionary Forces in France during World War I. Following the close of the war he became Major, Sanitary Reserve Corps, of the Medical Department of the U. S. Army, 1922–1937.

PLATE 1

Goldman as a Major, Sanitary Corps, U. S. Army, in France, World War I, 1918.

In order that Goldman could devote all of his time to scientific research and writings, he was relieved of all administrative work by the Biological Survey on

May 22, 1928, and from that time until his retirement in December, 1944 (when he was appointed Associate in Zoology, on the staff of the Smithsonian Institution

PLATE 2

Goldman loved his fishing—scene is a baby tarpon taken near Marco Island, Florida, April 2, 1940.

and continued as a collaborator in the Section of Biological Surveys, U. S. Fish and Wildlife Service), his efforts were exceedingly fruitful and productive. Even after retirement he devoted all spare time possible working on his "Mammals of

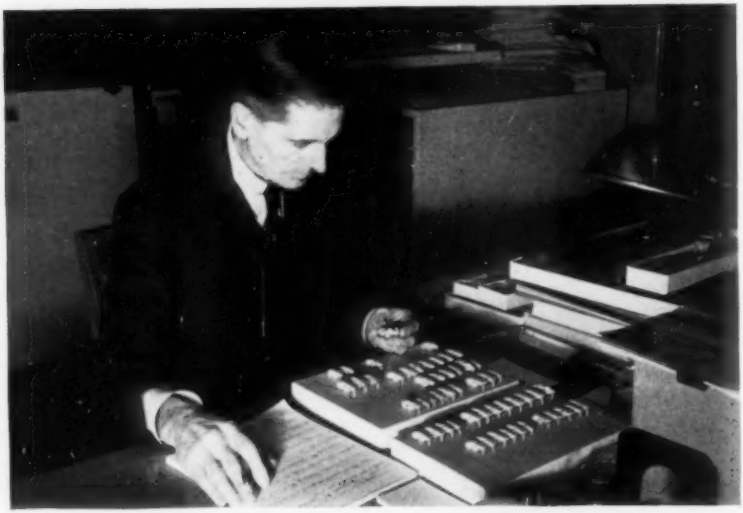

PLATE 3

UPPER: Goldman in his favorite field, revising a group of mammals, pocket gophers of the genus *Thomomys*. May 1940.

LOWER: Exchange of ratifications of a treaty between the United States and Mexico, for the protection of migratory birds and game mammals (in Washington, D. C., March 15, 1937). Seated, *left to right:*—Dr. Don Francisco Castillo Najera, Ambassador to the United States from Mexico; Cordell Hull, Secretary of State; Henry A. Wallace, Secretary of Agriculture. Standing, *in center:*—Major E. A. Goldman, of the Bureau of Biological Survey, who assisted in the technical phases of the negotiations for the treaty.

Mexico" until the eventful afternoon he was stricken. In fact as he closed his desk on that afternoon of August 30, when a symptom of thrombosis was making its appearance Goldman had nearly completed his description of a new Mexican mouse, found in the Nelson-Goldman collection as he carried on with the Mexican mammals.

Kindly, patient, he was always willing to drop the most exacting research to aid any associate or young naturalist who might contact him, all of which unselfishness often mitigated against his written production. One of Goldman's greatest assets was his ability to get along with everybody, never ruffled and seldom irritated. Goldman will remain as one of the outstanding mammalogists of the 20th Century. His name is indelibly inscribed in connection with Middle and North American mammalogy with a goodly sprinkle of ornithology and botany thrown in as he pursued his life's avocation.

His expertness in ornithology was recognized when he received the assignment to journey to Mexico City to assist in handling the technical phases in the negotiations with respect to the convention between the United States and Mexico for the protection of migratory birds and game mammals. This treaty was concluded on February 7, 1936, in the City of Mexico. As a result of Goldman's untiring efforts in behalf of the treaty, and following its final adoption, the United States Embassy at Mexico City officially stated to Cordell Hull, then Secretary of State, the following:

"I have the honor to inform the Department that Major E. A. Goldman, Senior Biologist, United States Biological Survey, rendered invaluable assistance in connection with signing of the Convention for the Preservation of Migratory Birds and Game Mammals. Major Goldman was recognized by the Mexicans, with whom the negotiations were conducted, as an authority on Mexican fauna and as one who was more familiar with this subject than were the Mexicans themselves. His interest and cooperation were particulary useful in connection with technical matters relating to the convention. It is respectfully suggested that the Department of Agriculture be informed of the Embassy's appreciation of the help rendered by Major Goldman throughout the negotiations."

During the long sojourn in Mexico, mainly during the regime of Porforio Diaz, the natives of that republic in its wilder sections were probably less law-abiding than at the present time. Consequently, both Goldman and Nelson were subjected to many hazardous experiences that often brought close contacts with bodily injuries, holdups, or brushes with the Grim Reaper, at the hand of prowling bandits. I often felt that following official retirement Goldman intended to publish a popular book descriptive of the Diaz regime as only he knew it. In this I believe he planned full accounts of his and Nelson's turbulent escapades at the hands of Mexican banditry during a time "when everybody carried a six-shooter on his hip by day and kept it under his pillow at night." There is no doubt he could have written a book dealing solely with hair-raising field experiences.

Several stories among many that Goldman told me in the course of our work on the manuscripts of "The Wolves of North America" and "The Puma, Mysterious American Cat," were narrated as follows:

One day twenty Indians, who thought Goldman was a government engineer surveying public lands used by the Indian communities, took after him in an earnest desire to perforate him with lead, believing that he intended to take their lands away from them. Some had pistols and others machetes and an unpassioned urge to lop off his head. For 10 hours he stood in the inner room of an adobe hut waiting to fight off the murder-bent natives. The Mexican who owned the hut convinced the Indians that Goldman was not inside. Under cover of a merciful starless night Goldman slipped through the line of sentries waiting for the 'government engineer' to return.

Another time he was arrested, thrown into a filthy jail following the shooting of a bird on Sunday near the town limits of a small Mexican hamlet. There he was confined until frantic appeals were finally relayed on to Nelson, momentarily held up in an adjacent Mexican town, who hastened pell-mell to Goldman's rescue with their American credentials, which Nelson carried. These were used to convince the Major Domo of the hamlet just what Goldman's occupation was. Even all this took additional prolonged entreaties from Nelson before Goldman was turned loose. When it was finally all settled the Major Domo, realizing the international *faux pas* he had committed, could not do enough for two naturalists, such as inviting them to his spacious apartments with all the trimmings (incidentally built over the jail where Goldman had been confined), but both refused with thanks and continued on their way collecting specimens, and ready for whatever might again come their way.

Near Toluca, late one evening as Goldman was returning from field work, he noticed three men with serapes wrapped tightly about them, approaching toward him along a narrow pathway. The men exchanged greetings with Goldman, but just as they were passing, one of them pulled his hand from beneath his serape and struck Goldman above the temple with a stone he had been concealing. The blow knocked him unconscious, and he was left for dead, but not until these renegades robbed him of all his possessions, including a bag of traps, altimeter, and shotgun. However, in a short time Goldman recovered sufficiently to stagger into town for help which was given to him. Later his belongings were recovered, following the rounding up of a gang of thieves in the immediate surroundings, and given back to him. The scar of that foul blow was carried on Goldman's left temple the rest of his life.

Educationally, Goldman was very much self-made. He was of the type often referred to and flippantly so, by some, as from the school of "range-raised naturalists and biologists." If what he accomplished in more than a half century's work in the field of conservation, zoology and natural history is any criteria, then the more we have of "range-raised naturalists" the better will be the great out-of-doors of these United States and its wildlife heritage in the future to come.

Grammer and high schools completed, Goldman's additional training came mainly in the "University of Hard Knocks" as the years passed by, during which interim he took several courses that fitted his particular calling.

From my long association with Goldman, I came to learn (and his immediate

family concurs with me) that though his expertness in his field came by long nerve exacting work, he had chosen his life's motto from the thoughts expressed in the words of Rudyard Kipling's "If", concerning which that eminent Englishman wrote:

If you can keep your head when all about you
Are losing theirs and blaming it on you;
If you can trust yourself when all men doubt you,
But make allowance for their doubting, too;
If you can wait, and not be tired by waiting,
Or being lied about, don't deal in lies,
Or being hated, don't give way to hating,
And yet don't look too good, or talk too wise;

If you can dream, and not make dreams your master;
If you can think—and not make thoughts your aim,
If you can meet with Triumph and Disaster
And treat these two imposters just the same;
If you can bear to hear the truth you've spoken
Twisted by knaves to make a trap for fools,
Or watch the things you've given your life to, broken
And stoop and build 'em up with worn-out tools;

If you can make one heap of all your winnings
And risk it on one turn of pitch-and-toss,
And lose, and start again at your beginnings
And never breathe a word about your loss;
If you can force your heart and nerve and sinew
To serve your turn long after they are gone,
And so hold on when there is nothing in you
Except the will which says to them, "Hold on:"

If you can talk with crowds and keep your virtue,
Or walk with Kings—nor lose the common touch,
If neither foes nor loving friends can hurt you,
If all men count with you, but none too much;
If you can fill the unforgiving minute
With sixty seconds' worth of distance run,
Yours is the Earth and everything that's in it,
And—what is more—you'll be a Man, my son!

His command of Spanish was almost perfect. Having mastered the rudiments of this language during his many years of work in Mexico, he later took courses in the subject so as to improve his mastery of it, particularly in the way the Castilians speak it. Thus, he was able to write and speak Spanish fluently. True was this also with respect to English. As opportunity and finances permitted, Goldman took special courses in rhetoric, proofreading, and the writing of manuscripts. His old personal files show his gradings in these subjects on the part of his professors as being almost one hundred percent. He had the art of using words that gave their greatest meaning in sentence construction and expressiveness. He was an inveterate reader, always seeking to better his technique. Few were ever so methodical.

Goldman also took up a deep study of photography, resulting in his becoming one of the best outdoor photographers in the old Biological Survey, and its successor, the present Fish and Wildlife Service. Few know that at one time in early manhood Goldman had seriously considered the study of medicine. Whether his early associations with Dr. A. K. Fisher, Dr. C. Hart Merriam, or Dr. T. S.Palmer had a bearing on this I was never able to ascertain.

Among his immediate associates Goldman was often referred to as the real "Noah" of the old Bureau of Biological Survey, because of the large number of mammals, birds, plants, reptiles and mollusks named for him, totaling something more than fifty. Briefly among the mammals given his name are a coyote, two pocket gophers, shrew, jaguar, flying squirrel, two pocket mice, a rabbit, ground squirrel, cotton rat, weasel, two wood rats, a rice rat, tree squirrel, white-footed mouse, and a harvest mouse. There are also a genus of wood rat and one of hummingbirds. Also a subspecies of trogon; and a species each of song sparrow yellowthroat, warbler, whippoorwill, shrike, vireo, ovenbird and motmot; a rattlesnake, a turtle, and a frog; and a univalve mollusk (*Bostricho centrum goldmani*) collected near Oaxaca, Mexico. Even the field of geography may be included pursuant to the name of Goldman Peak (5,000 feet) in Baja California, as a result of the Nelson-Goldman Expedition 1905-1906 that covered most of that peninsula. The results of this expedition were published by Nelson as a National Academy of Sciences memoir "Lower California and its Resources" in 1921. This will always remain a classic description of this Mexican State.

During his lifetime Goldman described well over 300 forms of mammals, most of them subspecies. At the time of the annual meeting of the American Society of Mammalogists in Chicago in June 1941, Wilfred H. Osgood as master of ceremonies concerned with the annual banquet frolics submitted the following question among others (to test the assembled members' knowledge of mammalogy): Who now living has described more forms than anyone else? The answer was Edward A. Goldman!

Goldman was a strong believer in evolution. His philosophy, as exemplified in the great number of mammals he described, is that any amount of constant variation in a geographic population, no matter how small, is incipient evolution and as such should be recognized. He relied mainly upon the standards of personal judgment when validating his descriptions. The recent developments of taxonomy in the fields of genetics and statistical analysis may show an ephemeral character to some of Goldman's described forms. However, such careful analysis will undoubtedly corroborate some of his findings and prove that accurate observations and seasoned personal judgment generally run parallel to the most complicated impersonal analysis.

At various times when fraternizing with mammalogists I have often heard it stated by many of them that if the opposite sex whom our various mammalogists had inveigled into marriage could be "Gallup polled" on the question: "Would you again marry a mammalogist?", the answer would overwhelmingly be "No"! What probably would cause the negative vote is that ever incessant urge on the part of the male member of such a calling "to be in the field", "collecting",

more collecting; "just one more specimen to round out a series."! All of which means much sacrifice of home life against milady's wishes. Goldman did his share, but the understanding Mrs. Goldman was a good soldier in this respect, and that "means everything to a man who scurries to all corners of a continent on a moment's notice."

Goldman, while attending a dancing party near Washington, D.C., in 1901, met, wooed and married Emma May Chase the following year. Throughout the happy years that followed, this union was blessed by a family of three stalwart sons, Nelson, Orville, and Luther, and a grandson Edward Luther Goldman. Of these Luther, a first Lieutenant in World War II, and employed in civilian life as a Refuge Manager by the Fish and Wildlife Service, is following in his father's footsteps, probably more in the field of ornithology at present than mammalogy. Other than his immediate family, Goldman has two living brothers, George and Luther, both of California.

His demise came suddenly. Returning to his office on the afternoon of August 30 from a visit to his beloved four-acre holdings at Shady Side, Maryland, where he and Mrs. Goldman and friends had spent so many pleasant times the past several years, he worked on his Mexican mammals. Post diagnosis showed that near 4 p.m. of that day symptoms of a thrombosis made its appearance. He, apparently ignorant of the symptom, journeyed home by bus, following which a doctor was called. He was put to bed, spent a restless following day, but the next day he improved, so much so, that one of his sons, Orville, and wife stayed with him until nearly midnight, talking over items of mutual interest. Common topic was what he intended to do when on his feet once again. But this was never to be, for at 5 a.m., on September 2, 1946, Goldman's end came suddenly and without suffering or pain.

His passing was a shock to all of his immediate friends, for physically, other than a developing slight deafness, he looked the picture of health. A common jocular remark often made to him by his acquaintances and fellow associates was to the effect he would "live to be 100".

Funeral services were conducted by the Masonic Order, to which Goldman belonged, in cooperation with the U. S. Army. Burial, with full military honors took place in Arlington National Cemetery on Friday, September 6, 1946.

(Goldman's published works, covering a span of 44 years (1902–1946) include a total of 206 titles. Among these in the press at the time of his death were "The Puma, Mysterious American Cat," in joint authorship with me; The Pocket Gophers, Genus *Thomomys*, of Arizona," which will be North American Fauna No. 59; and "A New Cotton Rat," in co-authorship with Marshall C. Gardner.

Goldman belonged to the American Association for the Advancement of Science (fellow), Washington Academy of Sciences, Biological Society of Washington (past president), American Ornithologists' Union, Cosmos Club, Explorers Club of New York, Cooper Ornithological Club, The American Society of Mammalogists (president of which he became in April 1946), the Baird Club (of which he was vice-president), and the Washington Biologists Field Club.

There are two ways to learn about the character of a man. First, camp in the field with him. Second, sit daily across a desk from him for a number of years. Either one or both might be called the great determinator in a man's appraisal of a man. It was my good fortune to have done both of these with Goldman. Never, did I find him wanting. His understanding, generosity, almost God-like even temperament probably accounts more than anything else for the fact that he never had, to the personal knowledge of his associates, one single personal enemy. He has left a host of sorrying friends.

Following is a list of Goldman's publications.

SCIENTIFIC PUBLICATIONS OF EDWARD A. GOLDMAN

1. In search of a new turkey in Arizona. The Auk, **19** (2): 121–127. April 1902.
2. Descriptions of five new mammals from Mexico. Proc. Biol. Soc. Wash., **17:** 79–82. March 21, 1904.
3. Twelve new wood rats of the genus *Neotoma*. Proc. Biol. Soc. Wash., **18:** 27-34. Feb. 2, 1905.
4. The green-winged teal (*Nettion carolinense*) breeding in California. The Condor, **10** (3): 129. May-June, 1908.
5. Summer birds of the Tulare Lake region. The Condor, **10** (5): 200–205. Sept.–Oct., 1908.
6. Eleven new mammals from Lower California. Proc. Biol. Soc. Wash., **22:** 23–28. March 10, 1909. [E. W. Nelson and E. A. Goldman.]
7. Five new wood rats of the genus *Neotoma* from Mexico. Proc. Biol. Soc. Wash., **22:** 139–142. June 25, 1909.
8. Revision of the wood rats of the genus *Neotoma*. North American Fauna, **31:** 1–124, pls. 8. Oct. 19, 1910.
9. A new species of arbutus. Contrib. U. S. Nat. Herbarium, **13** (pt. 9): 312. April 11, 1911. [J. N. Rose and E. A. Goldman.]
10. Two new shrubs from Lower California. Contrib. U. S. Nat. Herbarium, **13** (pt. 10): 375. June 8, 1911. [Paul C. Standley and E. A. Goldman.]
11. Revision of the spiny pocket mice (Genera *Heteromys* and *Liomys*). North American Fauna, **34:** 1–70, pls. 1–3. Sept. 7, 1911.
12. Three new mammals from Central and South America. Proc. Biol. Soc. Wash., **24:** 237–240. Nov. 28, 1911.
13. A new kingfisher from Panama. Smiths. Miscl. Coll., **56** (27) Publ. 2058: 1–2. Dec. 1, 1911.
14. A new weasel from Costa Rica. Proc. Biol. Soc. Wash., **25:** 9–10. Jan. 23, 1912.
15. Descriptions of twelve new species and subspecies of mammals from Panama. Smiths. Miscl. Coll., **56** (36) Publ. 2073: 1–11. Feb. 19, 1912.
16. The generic names *Cercomys* and *Proechimys*. Proc. Biol. Soc. Wash., **25:** 94. May 4, 1912.
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ASSOCIATION AND CORRESPONDENCE WITH GOLDMAN

By Hartley H. T. Jackson

One of the biologists I soon met when I first came to Washington to work in the United States Biological Survey, February 16, 1910, was Edward A. Goldman. It was Goldman who that first morning escorted me from the old red brick "Entomology Building" of the Department of Agriculture, across the Mall, through a locked gate in an eight-foot construction guard-fence, into the back entrance of the just-completed new National Museum, past the watchmen, and introduced me to the Biological Survey mammal collection and workers thereon, such as Arthur H. Howell, Clarence Birdseye, Daniel D. Streeter, and others. I had already met some of the old-timers previous to my coming to Washington, and others such as C. Hart Merriam, E. W. Nelson, Vernon Bailey, David Lantz, Ned Dearborn, Wells W. Cooke, Harry C. Oberholser, F. E. L. Beale, that morning at the main office. Goldman and I soon entered a friendship that gripped firmer each year of the 36-odd it lasted. We chatted and argued on all sorts of biological, socialogical, and administrative subjects. We often differed in opinions, but our differences cemented our respect for each other, and our friendship. For many years we went to lunch together, usually accompanied by Barton W. Evermann and Harry C. Oberholser, to a little grab-as-you-can restaurant on 11th Street, where the proprietor was so honest he expected his customers to be equally so, and allowed them to state to the cashier the price of the meal, and then pay. Possibly the owner gained by this, because I know that Goldman, as well as myself and the others with us, often in doubt as to the amount, gave the proprietor the benefit to the extent of a nickel or a dime.

With the exception of E. W. Nelson, I probably have spent as much time in official field work with Goldman as any other biologist, a considerable amount of which was in Arizona in 1915 and 1916, and more recently in Florida, Maryland, and Virginia. Although not so experienced in mammal field work at the time of the Arizona project as my companion, I nevertheless had made several successful field trips for the Biological Survey, as well as several for other institutions and myself before I came to the Bureau and was not exactly a novice at it. I was, therefore, often amused at the extent Goldman would go to explain the minutest details of trapping and preparing specimens, or even of camp cooking (the doing of which he actually disliked), so intent was he on having his ideas, usually excellent, properly instilled in other Survey personnel. He was a firm believer in setting many traps to insure a representative catch, and as a rule worked on a

basis of about 200 traps set at a time. He justly prided himself on his "take," and when his catch was excelled he expressed surprise with some such comment as "Gad, Jackson, you made a better catch last night than I did." He had equal pride in his bird records, and when on June 22, 1915, I established the Virginia Rail as a nesting species at Marsh Lake, Arizona, and thereby greatly extended its known breeding range (Goldman, E. A.: Condor, vol. 28, p. 163, July, 1926), he worked without cessation to equal the record, but with no selfish or unappreciative motive.

Goldman had a keen sense of humor and saw the funny side of many actions and events in the lives of both wild things and humans. The jack-rabbit at Holbrook, Arizona, that was so frightened by us that it ran pellmell towards a board gate, then stopped so abruptly it fell backwards, was much more comedy to E. A. than any stage vaudeville. He never indulged in practical jokes, but always received as much enjoyment from a joke on himself as on another. On one occasion, early in July, 1915, he had left our party to go to Stoneman Lake, on the Mogollon Plateau, Arizona, for a special study of wildlife conditions. On his return he said, "You know Jackson, I had a funny experience at Stoneman Lake. I saw a duck I could not identify and shot at it. I knew I hit it, but the damned thing just bobbed around and acted queer. So I blazed again, and the duck just rolled over on its side and back again. Then I realized I had been shooting at a decoy", he chuckled.

Goldman and I kept in fairly close touch with each other by correspondence when we were not together in the field, office, or laboratory. Some of his correspondence will throw light on his interests and life, and on mammalogical developments of the time. The following letters are, therefore, presented with little comment and as originally written. All letters were in handwriting. For the loan of my letter of February 7, 1919, to Major Goldman, I am indebted to his son, Luther C. Goldman.

On Active Service
with the
American Expeditionary Force.

AMERICAN RED CROSS

Central Medical Dept. Laboratory,
A. P. O. 721, A. E. F., France.

Dec. 27, 1918.

Dr. H. H. T. Jackson,
U. S. Biological Survey,
Washington, D. C.

Dear Jackson:

Well, the war is over and we all have time to take breath and begin to think of going home. When that may be for most of us is still however very indefinite. While the war was on I did not feel like doing much but plan for my work, and fume more or less because I could not immediately get help I saw would be urgently needed. But the boys are on the job now and I am happy as a clam. As a matter-of-fact we caught hold about depots at about the right time. Rats and mice were becoming troublesome, but had not had time to breed in sufficient numbers to become the great pest they would have been in a few months more.

By the way I have your data on the shrews to be examined in Paris, and will look them

up first chance I get. I have not been in Paris since receiving your letter with figures of teeth, but will plan to go there later. Early in the season I spent five days there when the city was dark at night and the long range gun was shooting in, to say nothing of the air raids which came practically every clear night. But I did not worry much about them—the area is so big that I figured there were plenty of places for those things to drop without singling out my immediate vicinity. The nearest anything came to me was when one of the long range shells exploded about 4 blocks away at 2 a.m. one night, and as far as I could learn next morning it did not do much damage.

Was very sorry to learn of the death of Prof. Lantz and of our efficient stenographer [Carl Olin Minor, who died from influenza]; also of Mabbott who was killed in action, but whom I did not know well.

Harper is sick in the hospital here with "flu", but seems to be pretty well over it and has had a mild case. I had a mild dose of it myself some time ago. I trust that you and your "better half" escaped. Incidentally give her my very best regards and tell her that I understand from Mrs. G. that she has rendered excellent war service.

I had a letter from J. L. Peters this evening. He is a 2nd Lieut. in the Q. M. Corps and seems to be enjoying his work. Says he has seen a good deal of active service.

Much of my energy for the next four months will be devoted to trying to keep warm. France has a beastly climate to my notion. I suppose "sunny France" is down in the lower right-hand corner where I have not been. I have a room here where I am preparing to keep as comfortable as possible when at my regular station. I spend considerable time at outside points, however, where I have to take pot luck. You know in Europe they do not keep houses nice and warm as we do. Still I think I can manage fairly well. An old lady and her son look after me. There is a little stove in the room, or rather a fairly big stove with a firebox for wood about the size of two vest pockets. About all I can say for it is it saves wood because it holds only about a handful at a time. Still it helps some and I am lucky to get any heat at all. But the old lady is very motherly and solicitous and before bed time puts a big hot brick in the bed to warm my feet, and it feels pretty good now that the weather is cold. I used to treat such things with contempt, but not in France!

Should be glad to hear how you are progressing with your field work and what you are "up to" generally.

Sincerely yours,
E. A. Goldman.

Biological Survey,
Washington, D. C.,
February 7, 1919.

Major Edward A. Goldman,
Sanitary Corps, U. S. A.,
Central Medical Dept. Laboratory,
A. P. O. 721, A. E. F., France.
Via New York.

My dear Goldman:

I was certainly glad to get your letter and to learn that you were getting along so well. Was also glad to know that you and Harper both got over the "flu" without serious consequences. It's bad stuff.

We've started organization plans for an "American Society of Mammalogists." It started in a Survey staff meeting held at Bailey's early in December. I was appointed chairman of the Committee, and along with me were Howell, Hollister, Preble, and Taylor. We have added Osgood, Grinnell, Stone, G. M. Allen, and J. A. Allen, to the committee and have a pretty good start toward a *real* foundation. The organization meeting will be held here in the New Museum building April 3 and 4. Of course you'll want to be down as a charter member. Ask the other boys about it too, when you get a chance. We expect to

publish a journal, and plan for studies in habits, life histories, ecology, etc., as well as "systematic stuff" (as Grinnell calls it). I think dues will be $3.00 for members. It looks as though there would be no class of fellows; sentiment seems to be against that distinction. Several of the mammal men here have donated $2.00 each to help defray cost of organization, —circularizing, etc., so that the society could start off without a mortgage on its future. If you would like to have your name on the list of men who have so given, of course, we would be only too glad to have your "two bucks". This, of course, is *not* a part of the annual dues. I'll send you circulars as soon as they are printed, and in the meantime I'm putting your name down on the charter membership list,—even though I do not hear from you before April 3—because I know you'll wish it there. Let me know about the other boys as soon as you can. Things are really looking very favorable for the outcome of the Society.

Piper has been here for a few days. He looks the same as usual. Dice was here today also. He is just mustered out. He may do field work in Montana this summer for Preble. Ligon (J. Stokley's brother) was also here today. You remember, he was on Old Baldy when we went up there to take our baptism [it rained steadily for 12 days] in July 1915.

I'm plugging away on my shrews and hope in time to get them straightened out after a fashion. They are a tough bunch. But something interesting turns up in them every little while. I am working on the *vagrans* bunch right now. I put them and *obscurus* in one "group". I've practically finished that outfit (*obscurus-vagrans*) now. Hoped to finish *Sorex* this winter, but it looks now as if I would have a little left over for next "season". Then there are all of the short-tailed shrews left. But I don't think they will take as much time as *Sorex* has.

My Wisconsin work is going nicely. Have added four or five new mammals to the state list, and several breeding birds. There is a lot of work to do yet though, especially on the birds. I just described (or have in press) a new *Napaeozapus* from the state,—a "bully" new form. Think the clay-colored sparrow I have been getting is new too, though I haven't made critical comparison yet. I want to work in the northwestern part of the state this summer, and on some of the islands in Lake Superior. Will probably start out early in May, as usual, and if possible I want to take Sheldon [Harry H.] with me. He will be good on the bird work, and there is a lot of it to do in a comparatively few days in spring.

Taylor had a rather mild case of the "flu" last month. Seemed to settle in his intestines. He is alright now. I had it in late October. Mrs. J. took good care of me so I pulled through nicely. Luckily she didn't catch it.

Howell expects to start for Florida about the first of next month. He will be back in May sometime. He is going to take Hardesty with him.

The War Risk Insurance have a new building,—or part of new building of the Treasury Dept.—, on the old Arlington Hotel site—H St. & Vermont Ave.,—so we are expecting them to move next month. It will be a relief to have the collection back down on the 1st floor again.

Well I guess I've told you all the news. Give my regards to the boys. Mrs. J. joins me in best wishes.

Sincerely yours,
Hartley H. T. Jackson.

Goldman, in reply to this letter, indicated that he thought that we might be able to get enough mammalogists interested in the Society so that we could make it worth while.

After he returned from France he was made Chief of the Division of Biological Investigations, in July, 1919. In reply to a note of congratulations I received the following letter while I was in the field in northern Wisconsin.

Washington, D. C.,
Aug. 11, 1919.

Dear Jackson:

Your letter of the 2nd inst. was received several days ago and much appreciated. It was a great surprise to me when I was told that I was to take charge of the Division. Will work for the fullest possible measure of success, and as far as I am able will see that everyone gets a square deal. Hope all will go smoothly and do not anticipate much trouble of any sort.

I note what you write about your mail and will turn it over to Preble hereafter. While he was out for awhile today I forwarded a couple of letters and I think one was for you. Preble will look after getting out supplies as a rule. I wrote you an official note today mainly regarding supplies he got off to you last week. As I wrote you it will be all right to take some leave, but you better send in an application as soon as you have returned to duty so you can complete it and I will approve it, or if it is at the end of your trip you can bring it with you.

I did feel very odd in civilian clothes after spending a year and a half in uniform. My coat felt as though it would fall off and I had a sloppy feeling all over. But it seems pretty good after all and I can appreciate the good old U. S. A. as never before. Will tell you all about it when you get back. By the way Mrs. G. and I had supper with your widow last night and she seemed to be standing the summer as well as could be expected. I suggested it might be a fine thing for you to spend the winter in the field, but she didn't seem to fall in with any such scheme at all, so I suppose you will have to come home. Funny how unreasonable women are, isn't it?

Am glad you are having a good field season. Mrs. J. showed us some post card photos of shore lines, etc. in the Apostle Islands and they look very interesting.

Harper is back in the office with a promotion to $1,600. Crick is down at Norfolk on a rat campaign. Kellogg has gone on out to California. I left Keyes in France, but supposed he would be over before this.

I have lots of things to discuss with you—too many to make much headway by letter and the Mrs. says it's bed time.

Let me hear more from you.

Sincerely yours,
E. A. Goldman.

U. S. Fish and Wildlife Service, Washington, 25, D. C.

EDWARD A. GOLDMAN

By Walter P. Taylor

According to my field diary, on May 2, 1916, I "Started from Washington, D. C. at 10:45 p.m., Southern Pacific Railway bound for San Carlos, Arizona, to assist E. A. Goldman in the biological survey of that state." So began my first field trip with the U. S. Biological Survey and a 30-year friendship with Goldman.

In those days the field work in rough country depended largely on horses, wagons, and packtrains. There were many occasions for fatigue and difficulty, but outstanding among my memories of Goldman is his persistent good humor in the face of any and every obstacle. I think Arizona was perhaps Goldman's favorite state. He never gave up a compelling interest in it. At intervals for more than 30 years he did biological field work in the region, although as a whole the job was never carried through to the stage of complete publication.

Goldman's field experience was broad, covering many localities in the United States and Mexico and even including a trip during the first World War, to Europe. So long and varied had been his contacts with Nature, and so adaptable his disposition, that Goldman was always very much at home in a, to him, friendly environment. But he seemed to appreciate the desert more than other types of habitat, and small wonder, when there be considered the pleasure of camping in a sunny and dry country, free from ticks, mosquitoes, or other pests, and in favorable weather perhaps the pleasantest climate in America in which to do field natural history.

Although Goldman always gave the impression of leisurely and unhurried action, in reality he was one of the fastest and most efficient field men with whom it has been my lot to work. Although mild-mannered and even-tempered, he was hard as a rock. He was an excellent hunter and field collector, as observant as an Indian, a good shot, and a keen naturalist. As a preparator of specimens he was unequalled. He worked rapidly and well.

An excellent sense of humor was one of his most attractive characteristics. On one occasion, he told me, he was sitting under the eaves of a 'dobe shack on a huge ranch on the Arizona desert skinning pocket mice, when a cloud of dust appeared on the horizon. The cloud soon resolved itself into a cowboy on horseback. The cowboy approached, dismounted and came close enough so he could see what Goldman was doing. "Well, I'll be goddammed!" was his only and eloquent comment.

A pleasant camp companion, a considerate supervisor, a good naturalist, a keen diagnostician in the field of mammalian taxonomy, an excellent writer, a generous cooperator, a loyal federal employee, and a conscientious family man and citizen, Goldman was one of the Biological Survey's most useful and productive leaders. I remember him best as a considerate and generous friend, as free from malice and guile as a quiet autumn sunset in the open mountain and desert country he loved so well.

Texas Cooperative Wildlife Research Unit, College Station, Texas.

FOOD AND MOISTURE REQUIREMENTS OF THE NELSON ANTELOPE GROUND SQUIRREL

By Albert C. Hawbecker

The Nelson antelope ground squirrel, *Ammospermophilus nelsoni* (see Bryant 1945), is an inhabitant of the dry plains and uplands of the western and southern fringes of the San Joaquin Valley of California. Its original range, according to early collecting records, extended over a much wider area than it now does, but has been, and is still being, restricted by cultivation. As early as 1919 Joseph Dixon (MS) found none around the type locality of Tipton, Tulare County, and each new section of ground that goes under the plow pushes back the range even farther. It has not been found in uncultivated spots surrounded by cultivated fields, probably because such spots here are usually alkaline, and so far I have not found any evidence of this squirrel living in soil too alkaline to support its common food plants.

HABITAT

The only other published studies on this squirrel are those of Taylor (1916) and Grinnell and Dixon (1918), both of which were carried on for the most part in or near Kern County. The present study was carried on at three different sites, all of which may be located on the Panoche Quadrangle of the United States Geological Survey. No exact figures could be obtained on rainfall for the specific areas, but all vegetation falls into the Lower Sonoran Zone category, as set forth by Hall and Grinnell (1919), or is annual in type, growing only during the season of rainfall.

The first area is in and adjacent to Ortigalita Canyon, six miles south and four miles west of Los Banos, Merced County, at elevations ranging from 200 to 500 feet. This area is absolutely devoid of brushy cover. Annual plants such as red brome (*Bromus rubens*), locoweed (*Astragalus oxyphysus*), soft chess (*Bromus mollis*), phalaris (*Phalaris minor*), red-stemmed filaree (*Erodium cicutarium*), and a little of the perennial spear grass (*Stipa pulchra*) have a short growing season. This lasts from the beginning of the rains in the last fall until the beginning of hot weather in the spring. The rest of the year, except for turpentine weed (*Trichostema lanceolatum*) in the summer and an occasional species of Compositae in the fall, the area is brown and exceedingly dry. The terrain is essentially rolling, with rock outcrops, and is often dissected by straight-walled dry washes. The second study area is the place where Little Panoche Creek leaves the hills, 21 miles west and 3 miles north of Mendota, Fresno County, 400 to 500 feet elevation. This area is much the same as the first in topography, vegetation, and rainfall. Grinnell and Dixon (*op. cit.*) describe such areas farther south as being covered with salt-bush (*Atriplex*), but only occasional bushes of this are seen in this area now, as it has been browsed to the stumps by countless sheep. The last study area is 11 miles east of Llanada, San Benito County, elevation 1100 to 1300 feet. Here the ground is quite rolling although not steep except where it rises to the hills. It is covered with the same type of annual vegetation

found on the other areas. Present also are ephedra (*Ephedra californica*), snakeweed (*Guiterrezia californica*), and an occasional California juniper (*Juniperus californicus*). Only the snakeweed extends over the whole of this area, and it is not a solid stand. Rainfall is apparently a little higher here and the growing season slightly longer, as the lower study areas are observed to dry up a little earlier and start growth a little later. This upper area was originally intensively pastured by sheep during the winter, but has served as a cattle range for the past two years. Because cattle are on the land all the year the whole site is practically devoid of herbaceous cover. This area has served as the main study area since 1943.

All soils where these squirrels have been found are sandy loam or fine sandy loam and give the appearance of being a deep, rich Panoche series soil type. The slightly rolling portions are gravelly clay loam and, although sometimes used, are not as popular as the bottomlands of lighter soils. These soils are easily dug even in the summer when they are very dry.

It may be well to say here that, as yet, no burrow systems have been found that could be definitely assumed to be of antelope ground squirrel origin. Careful observation coupled with careful excavation of burrows used by the squirrels, has always unearthed a system with old food caches so characteristic of abandoned kangaroo rat (*Dipodomys heermani tularensis* and *Dipodomys ingens* in this instance) systems. Other than mere tenancy, which in most instances appears to be very temporary, there are no characteristics which stamp burrows as antelope ground squirrel systems rather than kangaroo rat systems. These systems are located on little rises, which are probably the result of the digging of generations of rodents. These rises vary from a few inches to two and one-half feet in depth. One hundred to 200 square feet may be undermined with tunnels many of which open on the surface. This gives the squirrel many openings from which to peer, to scamper, or to which to retreat.

FOOD

This phase, a part of a more complete life history study, was carried on intensively from the fall of 1940 to the fall of 1943. Observations of a more casual nature were carried on in 1944. No work was done for most of 1945, but food conditions were found, by inquiry, to be the same as in previous years. Intensive study was started again in December 1945. Figure 1 shows the occurrence and approximate percentages of the various food types that might be found in any one month in the stomach of a given squirrel. No attempt has been made to keep exact amonts, as early studies showed they meant very little. The varying amount and types of food found in the stomach may depend upon the time of day, what a squirrel may happen upon, and the availability of the food type for that time of year. The graph shows that from the fall of 1940 to the fall of 1944, and probably to the fall of 1945, the food cycle was relatively constant. By reversing the seed and insect percentages one can get a picture of what happened in 1946 when there was a sudden change of summer food from grasshoppers to seeds.

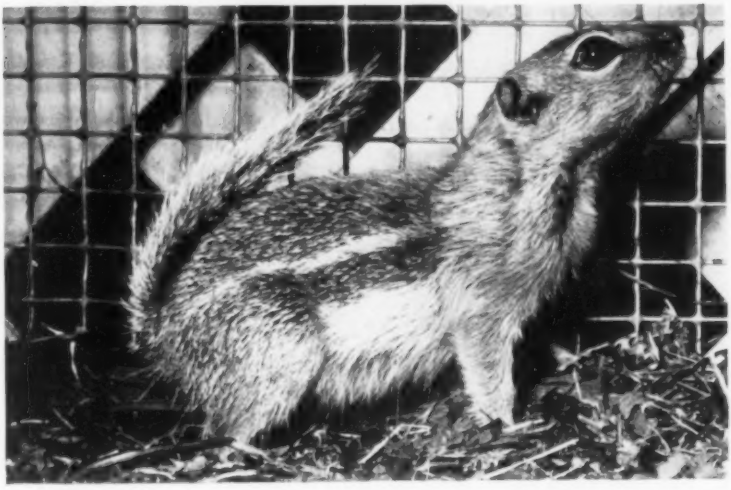

PLATE 1

UPPER: Captive young antelope ground squirrel. Markings and posture are very similar to those of the adult.

LOWER: Winter picture at Panoche Pass study area. Red brome (*Bromus rubens*) grass in the immediate foreground. Nearer shrubs are snakeweed (*Gutierrezia californica*), and the large ones on the rolling ground are ephedra (*Ephedra californica*).

Green Material.—The green growth begins in December, or even January, and lasts until April or early May. The extent of this growing season depends on when the first winter rains come, and when the spring rains stop and the summer heat begins. Growth is noticeably slow to start, except under the best of conditions, and plants begin to dry up at the first breath of hot weather. It was the end of January in 1943 before green material began to come, and the

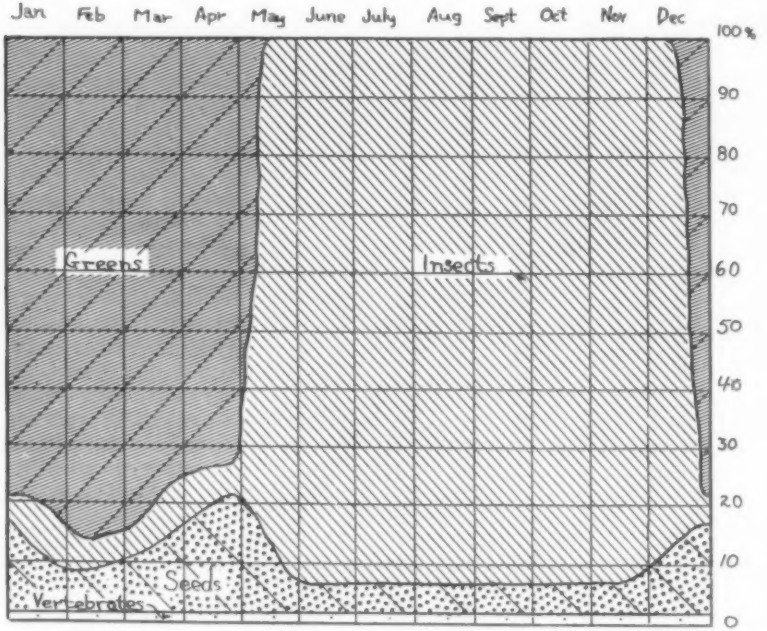

FIG. 1.—The occurrence and approximate percentages of various food types in stomachs of Nelson antelope ground squirrels by months. The period covered is from the fall of 1940 to the fall of 1944. This graph can be made to apply to 1946 by reversing the insect and seed percentages for the summer and fall periods.

first of May when it showed definite signs of drying up. Drying was well advanced by April 8, 1944, and by April 15, in 1946. On the other hand annual growth had started on November 29, 1946, which was quite early. Red-stemmed filaree (*Erodium cicutarium*) and red brome (*Bromus rubens*) are the most conspicuous of these annuals, with the former making the better early growth and the latter coming on and lasting later. The filaree dries up until little evidence of it is left, although seed is abundant. Except where cattle are present, red brome persists upright, although very dry, until the rains start. Both species are utilized in their green and dry states, especially the former, by both sheep and cattle. The plants used by the ground squirrels in the order of

importance are first, the aforementioned filaree and red brome grass, which appear to be of equal importance and far outstrip any of the other species. Next, ephedra (*Ephedra californica*) seeds are utilized when green and doughy. These provide some moist diet a little further into the summer. This species is limited however, and will be limited even more because no young plants are seen, due probably more to grazing than to the action of the squirrels. A species of clover (*Trifolium*) was found present in some Ortigalita-taken stomachs, and newly-sprouted locoweed (*Astragalus oxyphysus*) appeared to have been utilized there on December 10, 1941. Turpentine weed (*Trichostema lanceolatum*) was found in stomachs in October 1946, when food, especially moist food, was very scarce. It seems reasonable that any herbaceous or succulent green material will be utilized as long as it is available. Borderline species,such as turpentine weed, are used only in cases of extremity.

Insects.—As far as can be determined, this squirrel has no preference where insects are concerned. Occurrence in stomachs depends on availability. Decapitated, partly eaten, unidentified Coleoptera of several species are found about squirrel-frequented systems almost any time of year. The Jerusalem cricket (*Stenopelmatus longispina*) occurred twice in January-taken squirrels in Ortigalita Canyon, and other remains that looked like this insect were found in stomachs in the Panoche area during most of the spring months. Camel crickets (*Ceuthophilus californicus*) are often found when burrow systems are excavated and are found in the squirrel stomachs during the spring months. These two crickets are the winter and spring mainstays of the insect diet. The California June beetle (*Phyllophaga errans*) was found out in abundance on March 21, 1941, March 30, 1942, and April 15, 1946. This was before the grasshoppers had appeared and while green material was still available. These insects disappear when hot weather comes, but during their stay they are found in squirrel stomachs and the elytra are commonly found at the mouths of burrow systems frequented by the squirrels. The squirrels have also been seen pursuing them. A squirrel taken on April 12, 1941, contained, among other things, a species of Carabidae. The same warm weather that killed the herbaceous annuals brought out the nymphs of the grasshopper (*Oedaleonotus enigma*) as early as April 8, 1942, but not until after April 22 in 1943. A very few were seen on April 16, 1946, but only occasional adults were seen after that. This species was present until the advent of cold weather. Live ones were seen until December 18 in 1941, and a male squirrel was shot on December 29, 1944, carrying a blackened, dead grasshopper. Filaree and grass were just beginning to appear on that date. It seems then, that, except for 1946, grasshoppers lasted until the same rainy weather that brought on the green vegetation. Grasshoppers were found in almost all stomachs in large numbers as soon as they were available, and were the dominant item until they were no longer to be found. Harvester ants (*Pogonomyrmex*) were not found in the diet until the grasshopper failure of 1946, although they may have been used. It seems that this species may be used only when other insect food and other moist food are very scarce. A species of Tenebrionidae, probably *Eleodes*, was present

in numbers but was not found to be used by the squirrels. The possible relation of insects to moisture supply will be discussed later.

Seeds.—Seed material is found in a chewed-up, pasty mass in almost all stomachs every season of the year, although it often forms only a small percentage of the total contents. As far as can be determined, this material is either filaree, red brome, ephedra, or any combination of these. This is evidenced by the finding of at least some of the husks of these seeds in the stomachs, the actual observation of the squirrels eating them, or the finding of them in the cheek pouches. Grinnell and Dixon (*op. cit.*) record filaree seeds in pouches on May 11, 1911. A male collected on December 16, 1942, had readily identifiable red brome seeds in its stomach. In the Panoche area, both green and dry ephedra seeds are taken. Dry seeds of this species are rather starchy. They are picked off the shrub in the spring and picked up dry in the fall, at which time husks are commonly found around squirrel frequented burrows. Several young of the year were seen gathering and gleaning among husks on October 5, 1946, for ephedra seeds when other food was scarce. Sprouted seeds from kangaroo rat surface caches are dug up, apparently for the seed rather than for the shoot. It seems reasonable that any seeds palatable to the squirrel will be taken, but that the most easily obtainable, usually filaree and red brome, are the most commonly used.

Seeds are apparently not a favored food, but serve as a bridge or stop gap. The usual time that seed material reaches its highest percentage is when the more easily gathered green material or insects are absent. This happens in the spring between green material and insects and in the fall between insects and green material—and in the summer of 1946 when insects (grasshoppers) were absent. In that year seeds made up almost the entire bulk of summer food, except for what insects the squirrels could find. Seeds, of course, are everywhere abundant over the areas, and they seem to be a necessary adjunct to the diet. Generally, however, they seem to be considered too difficult to gather if something else suitable is present. Squirrels seen out during the summer of 1946 were far more active than those in previous summers. This was probably due to the necessity of gathering seeds because of the absence of easier-to-gather grasshoppers.

Vertebrates.—The "vertebrates' item is based on one known instance of a blue-bellied lizard (*Sceloporus occidentalis*) found in the stomach of an Ortigalita taken female squirrel on January 16, 1943, and on various unidentified items that appeared to be flesh. Grinnell and Dixon (*op. cit.*) record this squirrel as eating dried kangaroo rat flesh that they were using as bait.

Food in Captivity.—Captive specimens readily take rolled oats, rolled barley, chicken mash, rabbit pellets, and occasionally dog food. Flesh is taken readily and bones are gnawed to some degree. Almost any type of greens are acceptable. Salt cakes, such as given to rabbits, do not appear to be touched.

FORAGING HABITS

The antelope ground squirrel does not use the same method of obtaining food as does the Beechey ground squirrel (*Citellus beecheyi*). The latter has

a particular hole that serves as a base of operations and, although it may use others for temporary refuge, it always returns to the home burrow, and always returns to it at once, if possible. Rather than use one burrow or system as a base, the antelope ground squirrel appears to have a route that it covers, along which are a number of holes that it feeds around, and that it runs into if danger threatens. So far these burrows all appear to be of kangaroo rat origin. Certainly, there must be a definite den when there are helpless young

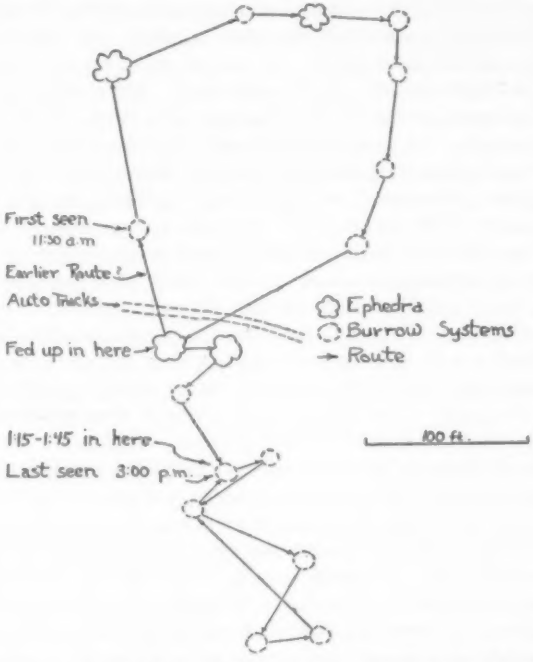

FIG. 2.—The route traveled by one Nelson antelope ground squirrel while foraging on April 12, 1943.

but even this is known to be abandoned as soon as the young are able to move about, that is, about weaning time. I believe there is some sort of home den, but so far this is merely conjecture.

Figure 2 shows the route covered by one foraging squirrel from 11:30 a.m. to 3:00 p.m. on April 12, 1943. Note how it traveled from burrow to burrow and from bush to bush, going around in a circle and finally retracing its steps. Several times it went down the same hole again and again, which made it appear that this was its home den, but it always came out and repeated the process elsewhere. The light of later evidence showed that, in the safety of the refuge burrow, it was probably devouring what it had stored earlier in its pouches.

During the winter, squirrels have been seen to cover a much larger area while foraging. Evidence of the beginning of a route was seen when six weaning young were watched on April 15 and 16, 1946, playing about what may have been their home den. This system had a number of entrances to which the youngsters scampered, or at which they appeared. The apparent mother was a female to which the young went, but by whom they were pushed away or ignored. She was using another system close by. Two of the young were seen to work out gradually farther and farther, smelling and watching as they went, until they finally got into a third system. Later they returned to the original system but kept venturing to the new one from time to time. An older brood, a little distance away and already weaned, was seen to use a route consisting of four burrow systems that formed a tight little circle. By October 5, 1946, what appeared to be the same broods had enlarged their routes to include burrows quite a distance away. A more interesting bit of evidence came up on May 19, 1942, when three captive adults were released after a two months' absence. They were quite a distance from their home territory, but still well within the present range of the species. When released they were utterly helpless, running this way and that, finally seeking shelter under the automobile. They were recaptured and pushed down a hole which they entered reluctantly. Apparently it was a suitable retreat for they did not reappear. Young squirrels captured, marked and released at their burrows go down immediately, but if they are released a long way from the system they are quite bewildered. In familiar country this squirrel always has a refuge along its route to which to dash in time of danger. The route is never found in deep grass or in shrubby areas, although shrubs are used as duck-in cover. It appears that knowledge of safe retreats is built up by investigation, probably by trial and error.

These squirrels do not stay long in one place, but move rapidly from refuge to refuge peering about and sampling. Everything is put to the mouth, chipmunk fashion, where it appears it is smelled or tasted, and accepted or discarded. As implied before, when the cheek pouches are filled, the squirrels retire to holes along the route and eat what they have gathered. A non-breeding female and male, collected on April 16, 1946, had well-filled cheek pouches of 1.0 and 4.1 grams of seed, respectively, and empty or nearly empty stomachs, which would indicate that they did not eat while foraging. This seed, filaree, had the outer husk removed enroute. Another female was collected on January 9, 1942, with cheek pouches well-filled with filaree seed. I have never found any sign of storage, and none of the above had young, so it appears that they gathered the food and then ate it in a safe place. On October 5, 1946, bunches of turpentine weed branchlets were found partly dragged into a burrow. These may have been brought to a safer place to eat. Insects, green material, and red brome seeds have seldom been found in pouches, making it appear that they may be eaten at once or carried to the retreat. The cheek pouches are extremely thin, so that the contents can readily be told without taking them out, and so thin that if empty they are readily missed in skinning the animal. Thus it is easy to see why insects or long, sharp seeds might not be readily carried in them.

On May 26, 1941, at Panoche I saw a group of three young squirrels, well grown by that time, that were using grasshoppers for food, but were discarding the large legs in a heap about the mouth of their burrow. On April 16, 1946, a squirrel was seen to catch a June beetle and run into a burrow with it. These instances indicate such things are eaten at the burrow.

After gleaning for a while, the length of time depending upon success or type of food, the squirrel will go down a hole and stay some time before starting out again.

The speed with which they forage and whether they eat on the spot may depend somewhat upon the weather. Pleasant days are spent out of the burrow feeding and apparently moving over quite a large area. Extremely hot and cold days are spent in the burrows with only enough time spent above ground to get food, and that during the mildest temperature of the daylight hours.

To gather green ephedra seeds, the squirrels climb into the shrubs; indeed it was this action that first called my attention to their using its seed. Caged specimens show great agility in climbing about their cage, even walking across the top upside down, clinging with their claws to the hardware cloth. They have been seen to catch grasshoppers by leaping with the insect until both came down at the same place at the same time. It seems probable that the squirrels must also stalk grasshoppers but it has never been observed. A June beetle was caught by a squirrel which ran along on its hind legs and pawed the air until it hit the low-flying insect. Another was caught by a sudden pounce. Caged young squirrels adeptly pounce upon grasshoppers put into their cage.

NEED OF VARIOUS FOOD TYPES

In considering the types of food and the methods of food-getting, it appears that certain foods are necessary to the well-being of the squirrel and are sought even though another food may be abundant. It will be noted that insects, flesh, and seeds were sought even when green material was very abundant. During the summer of 1946, when grasshoppers were absent and the squirrels were forced to subsist upon seeds, almost the only insects present were harvester ants (*Pogonomyrmex*), which, although always numerous, were found in the diet for the first time. This seems to indicate a need for such material. It will also be noted that seed material was taken at all times of the year, even when grasshoppers or green material were very abundant. This was most noticeable during the hot weather when grasshoppers were in the shade of every blade of grass, and the foraging time was very limited.

The following has not been substantiated by actual weighing, but by observation alone: Adult squirrels kept in captivity lost weight noticeably when kept on a seed and greens diet, although it is possible there was some other reason for the loss. Young squirrels fed a well rounded diet appeared sleek and well fed, but others did not develop so well on a seed-only diet. Captive young squirrels taken in the spring of 1946 and fed on a seed diet, did not compare favorably in size with those of the same year that were left to grow in the field and collected in the fall. It seems reasonable that certain, as yet unknown, food components

are furnished by each food type, making each type necessary to the diet over and above more abundant food.

MOISTURE REQUIREMENTS

As has been mentioned, these squirrels are very sensitive to high and low temperatures. During the hot months from May to September none was seen out in the heat of the day; early morning and late evening were the foraging times, which enabled them to avoid the heat. As far as can be found the adults are inactive during the summer, although aestivation has not been proven. Adults become very fat in the late spring, and then disappear during the hot summer months. The young, on the other hand, do not have the advantage of maturity and fat at this time, so are out every suitable moment getting enough food to enable them to maintain their rate of growth over the summer period. Intensive observation during the hot seasons of 1941–1943 and 1946 revealed only two adults seen or collected in summer, while many young were both seen and collected.

The young are produced during the period of green feed as Vorhies (1945) found for *Citellus tereticaudus*, and similarly there is no evidence of a second litter during the dry season. On April 16, 1946, young were observed being literally pushed away by the mother, who would not let them nurse. Green material was rapidly drying by this time and the mother spent her entire time away from her family, constantly eating. Practically the same thing was seen on April 22, 1943, also when vegetation was drying rapidly. It seemed that the parent wanted to rid herself of the young in order to prepare for the hot season.

It was first believed that the grasshoppers were a source of moisture which enabled the squirrels to exist during the hot months, but 1946 proved differently. The insects may have provided moisture, and they may also have provided ready food which made great activity unnecessary, but they were not an absolute necessity.

These squirrels live too far from a source of free water to make the trip every day, but when caged they were found to use water if it were given to them. Two inverted test tubes were used, with one being kept outside of the cage to test against evaporation. The water was lapped, or so it appeared, from the tube, but so much was wasted that an accurate check on the amount used could not be made. It was noted, however, that the tube had to be replenished far fewer times in cold weather than in warm. Captives fed on seeds and green material and kept in the shade during the hot weather were kept for seven months in the San Joaquin Valley without water. They appeared sleek and in no way emaciated.

It thus appears that the adults pass the dry, summer season in an inactive state, the depth of which has not been determined. The young, although necessarily active, avoid the heat of the day and seek moist food. This last was noted on October 5, 1946, when they were found eating turpentine weed and snakeweed, the only green plants in the area, which were always before shunned by these and all other mammals of the area, including domestic.

SUMMARY

The green parts and seeds of red-stemmed filaree and red brome grass are the main food plants used by the Nelson antelope ground squirrel in the areas studied. Insects, mainly grasshoppers, when available, are a staple of the diet. Seeds of ephedra are used where the shrub exists. Both seeds and insects seem to be a necessity, possibly a source of protein. In general, the type and amount of food found in stomachs seems to depend upon availability rather than upon any other factor.

Food is gathered along a route and consumed on the spot or in retreats along that route, depending upon the type of food.

The time of day of foraging depends upon the weather. Adults become inactive, to what extent is not yet known, to avoid summer heat and dryness. The young must forage during the summer and do so at the time of lowest daily temperature. Moist food is taken when and in what form possible during the summer.

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LONGEVITY OF SOME MICHIGAN FARM GAME MAMMALS

By J. P. Linduska

Although there is much interest and considerable speculation concerning the ages reached by many of our common animals living in the wild, there appear to be few factual accounts reporting such information. In 1939 Michigan's Game Division began a long-term study of farm wildlife at the Rose Lake Wildlife Experiment Station in Clinton County. In the continuous studies at this station, an extensive program of live-trapping and marking of a number of wildlife species have been routine. The accumulation of nearly seven years of records from these operations have produced interesting accounts for a number of individual animals of several species.

Since its inception, the Rose Lake Station has been open to closely supervised but unlimited hunting. The hunted area has varied in extent from 1,405 to 2,136 acres, and hunting pressure has averaged in excess of 200 gun-hours per 100 acres during the season. Rabbits and pheasants are legal game from October 15 to November 5 and rabbits from October 15 to December 31. All game taken on the area is checked at the headquarters laboratory. Total numbers of the principal game species killed on the area from 1940-1946 are as follows: Rabbits, 1513; pheasants, 974; and fox squirrels, 583. A close check on losses to other causes has been maintained through intensive year around field work.

Survival records for individuals of some of the commoner resident species are given below:

Cottontail rabbit, *Sylvilagus floridanus mearnsii* (Allen).—As is probably true of most small game species, rabbits are essentially an annual crop, and the numbers in any one year that survive to the second year are relatively few. Allen (1938, 1939) found that only 5 of 70 Michigan cottontails live-trapped in one winter could be accounted for in the second winter, even though 171 of a calculated population of 226 animals were taken during the second season. Allen reported two animals which were known to have lived 2½ years. Ingles (1941) in his studies of the Audubon cottontail (*Sylvilagus a. audubonii* (Baird) reported a maximum record of 19 months for one of 29 rabbits followed in his study.

In our work a number of second and third year animals are known, but from the more than 1,400 that have been marked the two shown below are the only rabbits known to have survived four years or longer.

Rabbit no. 14819 (17545) ♀. This rabbit, first trapped as a sub-adult in October 1941, was retrapped within 200 yards of its first capture point in June 1943, and after a three year lapse of time was again taken in June 1946 within 100 yards of the orginal trapping station. This animal, which was pregnant and lactating when last trapped, had survived five hunting seasons. Its weight of 3 pounds 14 ounces when last handled was about one-half pound more than the average for breeding females, and about one-half pound less than the maximum of 4 pounds 6 ounces found at Rose Lake for a female of unknown age. Interval between first and last captures: 4 years and 8 months. Probable age: 5 years.

Rabbit no. 5433 ♀. This individual, first trapped as a 1 pound 1 ounce juvenile on June 23, 1940, was retrapped four times in 1940, twice in 1941, and in January 1942 was one of six taken from beneath a brooder coop with a ferret. The animal was twice taken in 1943 and was last handled in September 1944. Trapping records fail to show that it was ever more than 100 yards from a two-acre swale where it was trapped 9 of the 11 times it was handled.

The weight at last handling was 3 pounds 7 ounces, average for adult females in summer. It had survived four hunting seasons. Interval between first and last captures: 4 years and 2 months. Probable age: 4 years and 4 months.

Western fox squirrel, *Sciurus niger rufiventer* (Geoffroy).—A review of records for more than 1500 fox squirrels tagged at Rose Lake shows that a number of animals have been accounted for over two and three year periods. However, the following five are the only individuals for which we have records extending over four years or more.

Squirrel no. 10296 ♂. First trapped as a 13-ounce juvenile in June 1941, this squirrel was taken three more times in 1941, three in 1942, three in 1943, once in 1944 and twice in 1946. Its weight of 1 pound and 9 ounces at the last handling in October 1946 was average for fall males. This animal apparently spent most of its five years of life within the limits of two adjoining woodlots about 9 and 16 acres in size. It had survived five hunting seasons, and was shot in its sixth season in a woodlot about ½ mile straight line distance from the two in which it had been regularly trapped. Interval between first and last captures: 5 years and 4 months. Probable age: 5 years and 6 months.

Squirrel no. 5896 ♂. When first trapped in October 1940, this squirrel weighed 1 pound 12 ounces, slightly above the average for autumn males. It was retaken later in 1940, and again in January, 1941. After a lapse of 4 years and 2 months, the animal was again captured at the same locality in March 1945. Records showed it was subsequently trapped in June 1945, and the last time in January 1946. Its weight at the last handling was 1 pound and 15 ounces, about 5 ounces heavier than the average male in winter. The animal had survived five seasons of hunting. Interval between first and last captures: 5 years and 3 months. Probable age: 5 years and 10 months (plus?).

Squirrel no. 15086 ♀. This juvenile animal weighed 1 pound 5 ounces when first taken in September 1941, and was rehandled once in 1941, once in 1942, and twice in 1943. After an interval of nearly three years it was again taken in June 1946 when it weighed 1 pound 8 ounces, about average weight for male squirrels in summer. In the six times it was trapped, this animal was taken in the same trapline and over a linear distance of less than 200 yards from the first point of capture. It has survived five hunting seasons. Interval between first and last captures: 4 years and 9 months. Probable age: 5 years and 2 months.

Squirrel no. 14490 ♂. This adult animal weighed 1 pound 9 ounces when first captured and tagged on September 18, 1941. It was retrapped in the same 5-acre woodlot three days later, and was not again taken until May 9, 1946, 4 years and 8 months later. The last capture was in a fence row trapline about ¼ mile from the woodlot in which it had previous residence. Its weight when last handled was 1 pound 13 ounces, about 6 ounces heavier than average for this sex in spring. The animal had lived through at least six hunting seasons. Interval between first and last captures: 4 years and 8 months. Probable age: 6 years and 2 months (plus?).

Squirrel no. 15353 ♀. This juvenile female was originally captured in June 1942, and weighed 1 pound 3 ounces. It was later taken five times in 1942, three times in 1943, three in 1944, 6 in 1945, and twice in 1946. Its weight when last handled in September 1946 was 1 pound 15 ounces, about 5 ounces above average for females in autumn, and its greatest recorded weight was 2 pounds even in March 1945. The animal was taken in three separate woodlots all located within an 80-acre area. Interval between first and last captures: 4 years and 3 months. Probable age: 4 years and 6 months.

Rufescent woodchuck, *Marmota monax monax* (Linnaeus).—A total of 196 woodchucks have been ear-tagged, and while a number of individuals have been retaken in the second summer, only four animals have been accounted for through three summers. Although there is an open hunting season for woodchucks in Michigan, hunting them is not popular in this area and none is known to have been killed by hunters on station lands.

Woodchuck no. 14326 (5176) ♂. This animal was an adult weighing 6 pounds 11 ounces when first trapped in August 1939. It was subsequently taken once in 1939, six times in 1940, four in 1941, and the last time in June 1942. Its weight when last handled was 9 pounds 2 ounces which was more than one pound less than its greatest recorded weight of

10 pounds 4 ounces in July 1941. Interval between first and last captures: 2 years and 10 months. Probable age: 4 years and 2 months (minimum).

Woodchuck no. 17386 (5429) ♀. When first live-trapped in July 1940, this juvenile animal weighed 2 pounds 7 ounces. It was handled only once thereafter in September 1943, when it weighed 7 pounds 4 ounces. Interval between first and last captures: 3 years and 2 months. Probable age: 3 years and 5 months.

Woodchuck no. 10241 (5441) ♀. First taken as a juvenile in July 1940, when it weighed 3 pounds 1 ounce. Later captures were once in 1940, twice in 1941, and the final instance in June 1943. Its weight at last handling was 8 pounds 9 ounces, which was also its heaviest known weight. Interval between first and last captures: 2 years and 11 months. Probable age: 3 years and 2 months.

Woodchuck no. 9879 (1864 and 27) ♀. This individual was an old animal at first capture in July 1939. It was later taken five times in 1940, twice in 1941, and the last time in April, 1942. A weight record at the first handling was not obtained, but it weighed 6 pounds 3 ounces in May 1940, and 8 pounds 5 ounces in July 1941, the period of its greatest known weight. Its weight when last trapped was 6 pounds 3 ounces, over 2 pounds less than its observed maximum. Interval between first and last captures: 2 years and 9 months. Probable age: 4 years and 0 months (minimum).

Raccoon, *Procyon lotor lotor* (Linnaeus).—Stuewer (1943) in a detailed study of raccoons in Allegan County, Michigan, handled 256 individuals, and found that among 167 juveniles only 31 were subsequently handled as adults. He cites reports of captive animals that were 8 years of age, but questions whether many wild animals reach that age because of heavy hunting. Of his own experience with wild raccoons Stuewer comments on their longevity, "... several individuals with badly worn teeth were handled, which probably were several years old." Recently F. W. Stuewer (personal communication) informed me that a young raccoon first live-trapped by him in August 1940, had been taken by a trapper in December 1946, at the same locality. This animal, probably born in the spring of 1939, was at least 7 years and 7 months old.

In our work a total of 148 raccoons have been ear-tagged in the past seven years. A number of these animals have been retaken in the second year following the initial trapping and a few reappeared in the third year. However, only one animal has been accounted for through a period of four or more years.

Raccoon no. 11109 (8180) ♀. This animal when first trapped in October 1940 weighed 8 pounds and 11 ounces. It was handled once in 1941 and reported shot in December 1944. Its weight when killed was not reported. The interval between initial capture and kill by a hunter was 4 years and 2 months, and its probable minimum age when shot was 4 years and 8 months.

OTHER SPECIES

Opossum, *Didelphis v. virginiana* (Kerr).—Although 216 individuals have been ear-tagged, only a few were retaken a year later and none was known to have survived or remained on the area for two years.

Eastern skunk, *Mephitis mephitis nigra* (Peale and Beauvois).—Only 1 of 115 skunks trapped on the area is known to have been on the area more than two years following the first capture. This animal, a female, (no. 17868) was first caught in September 1943, and was found dead from unknown causes in March 1946. Within the period covered by this report there has been good evidence of skunks being decimated by a virus-like disease. A 1940 die-off that quite likely was state-wide was apparent at Rose Lake (Allen, 1942). There is no question but that this epidemic reduced the survival chances for skunks in this area.

Weasel, *Mustela frenata noveboracensis* (Emmons).—A few of 73 ear-tagged weasels repeated in traps a year after the first capture, but none of these was accountable for at the end of the second year.

Badger, *Taxidea taxus taxus* (Schreber).—Only one of five was ever recaptured on the area and this one in the same year of tagging. The grizzled appearance of at least two of the badgers, however, was that of animals several years old.

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GROWTH, DEVELOPMENTAL FOOD REQUIREMENTS, AND BREEDING ACTIVITY OF THE CALIFORNIA JACK RABBIT

BY HORACE S. HASKELL AND HUDSON G. REYNOLDS

Since young California jack rabbits (*Lepus californicus eremicus* Allen) are rarely observed or captured in the wild (Vorhies and Taylor, 1933), little is known of the early life history of this subspecies. This paper presents data and observations on this phase of the life history of some of these rabbits that were raised from birth in captivity. The investigation is a part of the work being carried on in cooperation with the Southwestern Forest and Range Experiment Station to determine the influence of jack rabbits on grazing lands. The assistance given by officials of that station, especially Matt J. Culley, is gratefully acknowledged. Dr. C. T. Vorhies, of the University of Arizona, prepared all museum skins and generously consented to their use for study and illustration. In addition, his critical reading of the manuscript, and his helpful suggestions are greatly appreciated.

PROCEDURE

A study of the growth, development, and food requirements of the young born to three females and one male, raised by Arnold (1942) from caesarian births, was commenced in January 1943, and continued with their offspring during 1944.

An enclosure about $\frac{1}{5}$ acre in size was used to confine the breeding stock except at kindling when females were isolated in cages with a floor space of about 300 square feet until the end of the nursing period. Young animals were kept in similiar cages until they reached maturity.

Records of total length, length of hind foot, and length of ear; weight; and forage consumption of the young were maintained from birth to eight months.

Body measurements were taken as follows: total length, from the tip of the nose to the end of the last vertebrae in the tail; hind foot length, from the heel to the end of the longest nail; ear, from the notch to the tip of the ear. The errors resulting from measuring live animals were kept as small as possible by taking successive measurements until consistent results were obtained. Weights to the closest gram were taken on a torsion scale balance. Forage consumption was determined by weighing in and out daily the forage ration, which consisted of an excess of rolled barley supplemented by dried alfalfa leaves.

BEHAVIOR AND PARENTAL RELATIONSHIPS

Young rabbits, although precocious, did not exhibit well coordinated hopping activity until two or three days of age. Until about one week of age, they suckled by lying on their backs with their hind feet around the neck of the doe. Thereafter, they changed their nursing posture to an upright position, or occasionally reverting to prostrate feeding. At first, nursing during the middle of the day was common, but soon such activity was confined to the morning and evening hours. This behavior was comparable to that noted for Allen's jack rabbit by Vorhies (1921). Although quiescent during the daylight hours, when molested most of the young tended to "spit and box" with such ferocity as to frighten an unknowing intruder.

At about ten days of age, young rabbits supplemented their milk diet with solid food, and at an age of about three weeks, they shifted successfully for themselves on a dry ration of rolled barley and alfalfa.

Does thoroughly cleansed the young of all afterbirth immediately after parturition. They continued to lick the sexual organs and navels of the young throughout the nursing period.

Until pellets were voided by young animals at about two weeks of age, does sucked the anuses of the young. Possibly, this behavior by the does served to prevent constipation. In the wild such an adaption might also serve to remove the odor of fecal material so that predators would not be attracted to the young rabbits.

DEVELOPMENT AND GROWTH

Young rabbits were fully clothed with hair at birth and exhibited the characteristic marks of the species, black ear tips and a black tail (Plate 1). The natal pelage was dark, and was gradually replaced by a lighter immature coat. A small white patch, often present in the center of the forehead at birth, disappeared at the age of about three months as the immature coat was assumed. The adult pelage became apparent the first winter when the animals were six to nine months of age.

One oddity of young rabbits was the relatively short head which gave a flattened appearance to the face. This condition persisted for about a week. The head then began to lengthen and by three weeks of age normal shape was attained. Possibly, this "snubbiness" of the head makes parturition easier for the females and assists the young animals in gaining access to a nipple while nursing.

Body measurements and weights of six male and eight female rabbits in relation to age are shown in figures 1 and 2. Weekly values read from these curves are given in Table 1. Curves were prepared by fitting a free-hand line through the weekly measurements for all rabbits. They were balanced by equalizing positive and negative deviations in parts (Bruce and Schumacher, 1935).

Ear and hind foot matured at about 15 weeks; weight at 32 weeks; and total length at 28 weeks of age. Except for ear measurements, there was no obvious

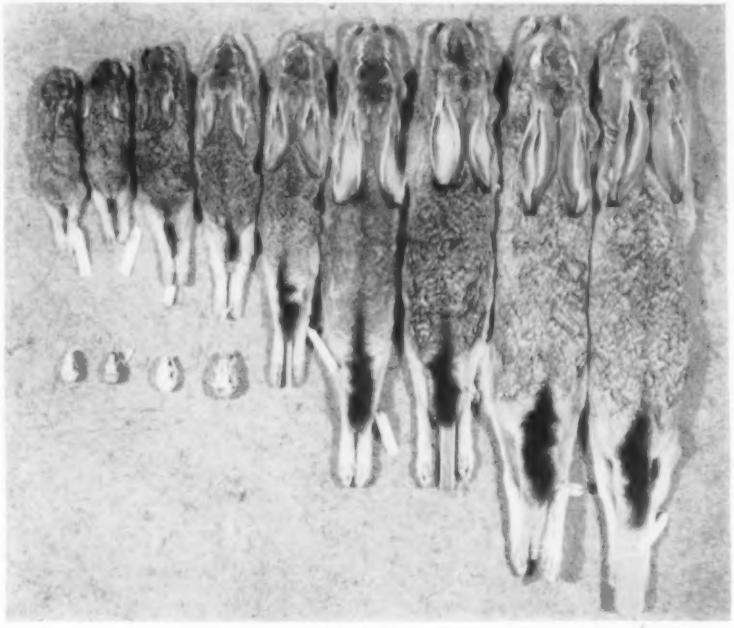

PLATE 1

A series of study skins and skulls of the California jack rabbit. Ages of animals are, from left to right, 12 hours; 4 days; 1, 2, 4, 8, 12, 26, and 52 weeks, respectively.

difference between sexes. The curves agree closely in form with those presented by Severaid (1942) for the snowshoe hare. Ear and weight maturity are reached by both species at about the same age, but the hind foot of the California jack rabbit matures some five weeks earlier.

Average mature weights and measurements as determined by Vorhies and Taylor (*op. cit.*) are compared with those of animals raised in captivity in Table 1. The comparison suggests that captive animals experienced no measurable abnormal development due to confinement.

FORAGE REQUIREMENTS

Forage requirements were determined from individual feeding trials with five males and six females. Average weekly consumption of rolled barley and

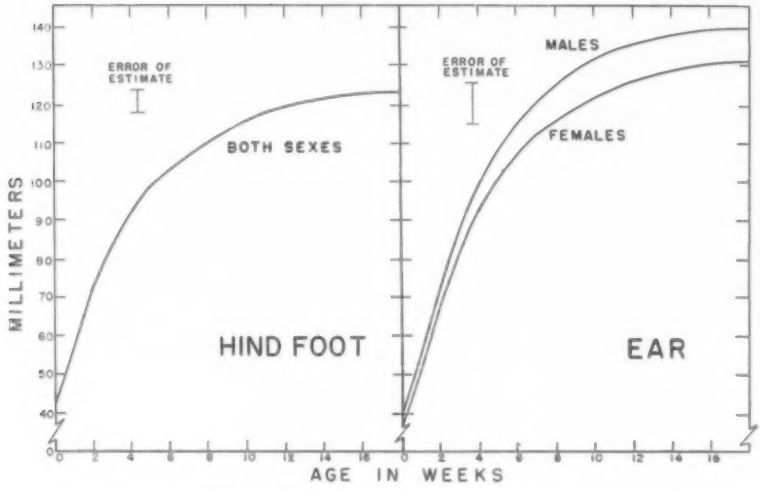

FIG. 1.—Average hind foot and ear growth of California jack rabbits from birth to maturity.

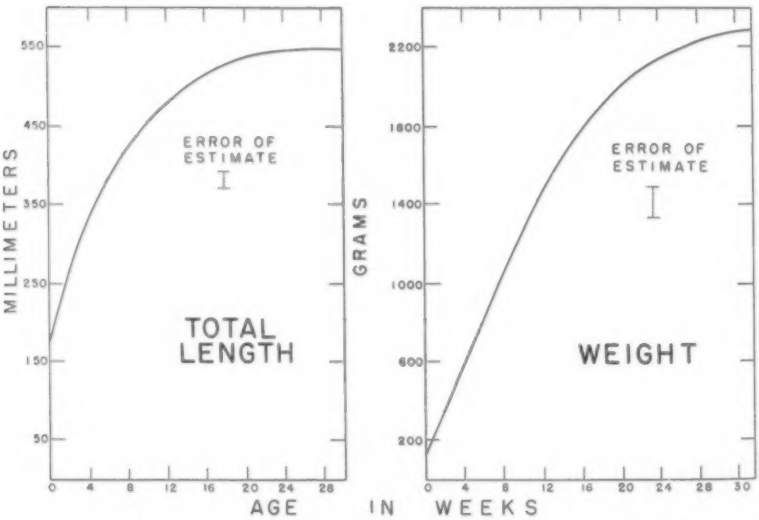

FIG. 2.—Average increase in body length and weight of California jack rabbits from birth to maturity.

alfalfa was converted to thermal units based upon the constants of Morrison (1940) for cattle and sheep. Thermal unit figures for each rabbit were averaged

TABLE 1.—*Weekly growth measurements and food requirements of California jack rabbits from birth to maturity as determined from curved averages*

AGE WEEKS	MEASUREMENTS IN MILLIMETERS				WEIGHT IN GRAMS	FOOD CONSUMPTION IN THERMS
	Length	Hind Foot	Ear (male)	Ear (female)		
Birth	168	43	39	37	110	—
1	207	58	53	51	210	—
2	255	74	72	70	330	—
3	300	85	89	83	450	.018
4	336	93	100	93	580	.030
5	363	99	108	101	700	.044
6	387	104	114	108	825	.059
7	401	108	119	112	940	.070
8	419	111	123	116	1,050	.079
9	437	114	127	120	1,160	.087
10	452	116	130	122	1,260	.093
11	467	118	133	124	1,370	.099
12	482	120	135	126	1,460	.104
13	494	121	137	128	1,550	.109
14	503	122	138	129	1,640	.112
15	512	123	139	130	1,720	.115
16	521	123	139	131	1,800	.118
17	527	—	—	131	1,870	.121
18	533	—	—	—	1,900	.123
19	539	—	—	—	1,975	.125
20	542	—	—	—	2,015	.127
21	543	—	—	—	2,060	.129
22	545	—	—	—	2,100	.131
23	546	—	—	—	2,150	.132
24	548	—	—	—	2,160	.133
25	549	—	—	—	2,190	.134
26	551	—	—	—	2,210	.134
27	552	—	—	—	2,230	.135
28	553	—	—	—	2,250	.135
29	553	—	—	—	2,260	—
30	—	—	—	—	2,275	—
31	—	—	—	—	2,290	—
32	—	—	—	—	2,300	—
33	—	—	—	—	2,300	—
Average Body Measurements Determined by Vorhies and Taylor, 1933						
Mature	556	132	143	136	2,300	

by curving the same manner as were body measurements. Weekly values of food consumption are presented in Table 1.

Thermal units were converted to natural forage consumption by equating constants for growing animals with those for mature rabbits. Arnold (*op. cit.*)

found that mature Arizona jack rabbits required an average daily consumption of 0.23 pounds of a ration composed of 1.7 parts of alfalfa to 1.0 part of barley. This ration was equivalent to an average consumption of 0.27 pounds of air-dry native forage. The results of the conversions are given in figure 3. These native forage conversions are subject to several sources of error, which include those of the original determinations of the thermal values for livestock; the use of factors for one species of animal for another; the variations in food consumption produced by forage combinations; and discrepancies which are related to different levels of food intake. Two comparisons, however, suggest that

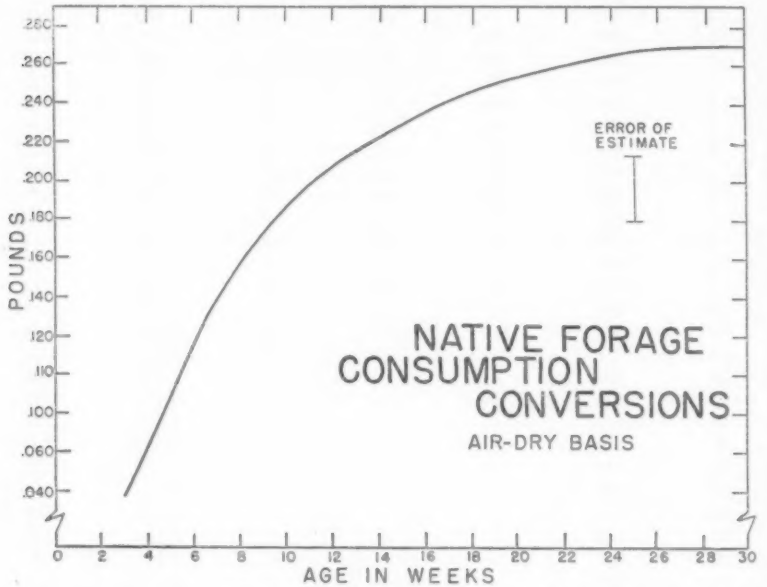

FIG. 3.—Average consumption of native forage by growing California jack rabbits based upon conversions from a hand fed ration of rolled barley and alfalfa leaves.

factors of food consumption are reasonable enough to be of value in estimating forage destruction by young rabbits. First, forage consumption shows a curvilinear relationship to age which is similiar to that of body growth. Secondly, forage requirement leveled off to an average constant amount of 0.27 pounds at the age of 28 to 30 weeks which is the same as the average determined by Arnold for mature Arizona jack rabbits.

BREEDING RELATIONSHIPS

Sexes were highly tolerant of each other in captivity. Even two males seeking the same female did not fight. During courtship, females led the males a vigorous chase which often lasted for fifteen minutes. Copulation, although

occurring most commonly at night, often took place in the late afternoon. Some females accepted males on the day of parturition. In such instances, the males sometimes assisted the females in disposing of afterbirth. Breeding was at all times promiscuous, females accepting the first interested male available

The 1943 breeding season extended from December 1942, when the first male sexual activity was noted, until November 1943, when the last male activity occurred. The first birth in 1943 took place on February 11 and the last on September 27. In 1944, the first birth occurred on February 10 and the last on September 19. These observations concur with those of Vorhies and Taylor who found the breeding season extending nearly throughout the year under natural conditions.

Although some young females reached maturity before the end of the breeding season in which they were born, they produced no young until the following season. A female born on February 11, 1943 did not kindle until March 6, 1944. Another born in March 1943 produced her first litter in June, 1944. Six females born during the interval June to August in 1943, produced young in the period March to May of 1944.

Some captive animals, released at the age of seven years, were still actively breeding. Arizona jack rabbits probably do not reach such an advanced age under natural conditions. Accordingly, the conclusion seems warranted that Arizona jack rabbits are active breeders throughout normal life.

REPRODUCTIVE POTENTIAL

Tests with eight females gave an average gestation period of 43 (41–47) days. Two females produced five and six litters per year. The usual number of litters per year was, however, more nearly four. The average number of young produced by all females in captivity was 1.79 per litter. This average is slightly less than the figure of 2.24 determined in the field by Vorhies and Taylor.

Age of does had no perceptible effect on size of litters. All animals, irrespective of age, had, however, a tendency to produce larger litters during the latter part of the breeding season.

Breeding potential estimated by either of two methods places the capacity of California jack rabbits at 13 to 14 young per female per year. A maximum of six litters per year with 2.24 young per litter gives an estimate of 13.4 young per female per year. Assuming rebreeding to occur on the day of parturition, a 43 day gestation period extending over nine months, with 2.24 young per litter, gives a breeding potential of 14.1 young per female. Severaid (1945) reports a breeding potential of 8.7 young per female for the snow-shoe hare. Such high breeding capacities are probably never realized under natural conditions.

SUMMARY

1. Data on the growth, development, breeding, and food requirements of a number of California jack rabbits raised in captivity are presented.

2. The ear and hind foot of these animals reached maturity at 15 weeks, weight at 32 weeks, and total length at 28 weeks.

3. Ear length was the only measurement which differed perceptibly between sexes: it was greater in males.

4. Forage consumption showed a curvilinear relationship to age from 3 to 28 weeks, after which an average constant amount equivalent to 0.27 pounds of air-dry native forage was consumed.

5. Females born early in one breeding season, although maturing before the end of the breeding season, did not produce young until the following year.

6. The average gestation period in captivity was 43 (41–47) days.

7. Active breeding apparently occurs throughout normal life, since some captive animals were still actively breeding when released at an age of seven years.

8. The maximum breeding potential for these rabbits was calculated to average 13 to 14 young per female per year.

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OWL PREDATION IN PENNSYLVANIA, WITH NOTES ON THE SMALL MAMMALS OF DELAWARE COUNTY

By Oliver P. Pearson and Anita K. Pearson

Owl pellets have been used frequently in studies of the food of owls, but seldom has full use of them been made in studying the small mammals of a region. The collecting ability of an owl is astonishing, and if the pellets, or castings, are collected at regular intervals, considerably more information can be gathered than is supplied by the usual list of animals eaten. We have attempted in this paper not only to report on the mammals of a region, but also to compare the catch of owls and trappers in the same region at the same time.

Pellets from six different roosts were examined in this study. The regurgitated castings of bones and hair were picked apart and the prey was identified from the skulls and teeth, and in a few cases from other diagnostic bones.

Delaware County is to the west of and adjacent to Philadelphia County. The terrain for the most part is rolling farm country with numerous woodlots, but there are considerable areas of marsh along the Delaware River, and numerous thickly populated suburbs. The entire region is in the Austral Zone.

PELLETS FROM BARN OWLS AT EDGMONT

Our most complete collection of pellets came from a barn near Edgmont (Edgemont on some maps). When first visited in the company of Dr. Robert Stabler on June 7, 1945, there were five half-grown barn owls (*Tyto alba pratincola*) in the nest. The parents were not in attendance and had probably been frightened away by workmen in the barn. Subsequent visits were made to the barn at intervals of about 3 weeks and a dated series of pellets obtained. One of the young owls died while it was still downy, but the others were reared successfully. There were always one or two owls found in the barn on subsequent visits, but it is not known whether these were the parents or the young. Two eggs were laid in the same nest during October, but apparently these were not incubated and they never hatched. Owls were still present when collecting was discontinued on January 27, 1946.

Edgmont lies among rolling hills in a region of small farms and numerous woodlots. The barn itself was situated near the bottom of a bowl transected by Ridley Creek. The terrain nearby was pasture, woodland, hillsides covered with tall grasses such as *Andropogon*, cultivated fields, and a swampy meadow of about three acres extent growing to low grasses and herbs, clumps of *Carex*, and occasional alders. The woodlots were composed principally of beech, tulip, and oak trees, with very little undergrowth.

Judging from the number of pellets collected at each visit to the barn, it appeared that each owl usually produced one pellet per day. Slower pellet production than this was infrequent and probably depended on weather conditions. Ejection of two pellets per day was probably more frequent. Guérin (1928) states that barn owls produce two pellets each 24 hours, one at night at a "station nocturne" and another during the day at a "station diurne." If

such was the case with our owls, we were collecting only from the "station diurne" and consequently counted only about half the total catch. In any event, the contents of each pellet represents a minimum estimate of the number of prey caught and eaten by one owl in one night. Additional animals may have been caught but not eaten, and nights may have passed when nothing was eaten and no pellet produced. All the pellets from these owls contained an average of 3.0 animals per pellet, and this may be taken as a minimum value for the average catch of each owl per hunting night. It will be noted in Table 1, however, that the number of animals contained in each pellet varied considerably from month to month. The high of 4.0 animals per pellet came in June, a low of only 2.0 in September, and a prolonged low period followed

TABLE 1.—*Catch of the Edgmont barn owls, by percentages*

	DATES WHEN PELLETS WERE COLLECTED											PERCENT OF TOTAL
	June 7	June 30	July 23	Aug. 12	Sept. 4	Sept. 22	Oct. 10	Oct. 31	Dec. 1	Dec. 27	Jan. 27	
Microtus	63	56	56	57	81	72	74	76	73	70	75	64.8
Pitymys	2	3	4	4	0	7	5	0	4	0	0	2.6
Mus	2	3	2	1	3	4	7	5	3	3	2	2.7
Rattus	1	0	0	1	0	0	0	0	0	0	0	0.3
Peromyscus	3	6	7	5	5	0	0	0	6	13	4	4.3
Zapus	4	4	6	5	2	0	5	7	1	0	0	3.8
Sylvilagus	5	2	0	0	2	2	0	0	0	0	0	2.3
Blarina	13	24	17	13	3	4	9	12	13	13	18	13.8
Sorex	3	0	1	1	0	2	0	0	0	3	2	1.7
Cryptotis	0	1	1	1	0	0	0	0	0	0	0	0.3
Condylura	2	1	5	1	0	2	0	0	0	0	0	1.6
Bird	1	0	2	1	0	2	0	0	0	0	0	0.9
Katydids	0	0	0	7	2	4	0	0	0	0	0	0.7
Total number of animals	412	139	126	78	64	46	58	58	78	38	55	1152
Average size of pellets	3.2	4.0	3.1	3.3	2.4	2.0	2.3	3.4	2.5	2.5	2.5	3.0

during December and January. The reason for this fluctuation is not known. It seems certain that the number of prey available is not a major cause, for there are many more mice and shrews in September than in June.

During the 8 months that these owls were under observation, they ate at least 740 prey. Since the number of owls living in the barn was not always known (usually one or two), the catch cannot be reduced to a per-owl basis. It is convenient, however, to think of this "family" or "squadron" of owls as a unit removing mice and other small mammals at a rate of 3.2 per night. The catch for the "family" was as high as 5.0 per night in June while the young were being raised, and dropped rather steadily to a low of 1.4 in December. These figures again must be considered minima, for many animals may have been caught and not eaten, and some pellets undoubtedly were ejected outside the barn.

If each pair of owls covers about one square mile (Griscom, 1942) or 640 acres, then at the average rate of 3.2 mice or shrews caught each night these owls would be reducing the prey population at a rate of more than 1.8 animals per acre per year. This amounts roughly to about 10–20 percent of the average prey population at any one time. Transposed to a per-day basis, this agrees almost perfectly with the rate of attrition calculated by Chitty (1938), who estimated that gray owls in one region of Great Britain eat .02 to .05 percent of the vole population daily.

It may be seen in Table 1 that with the exception of house mice, and possibly rats and pine mice, the percentage of the species making up the diet varies considerably from month to month. Whereas meadow mice always occurred in the pellets more frequently than all other species combined, their numbers varied from 56 percent of the catch in June and July to 81 percent in late August and early September, and over 70 percent from late August through January. The scarcity of meadow mice in the pellets in the spring and summer is compensated for by a relative increase of many other species, some of them rather scarce forms, such as long-tailed shrews, little short-tailed shrews, and star-nosed moles, as well as an increase in the percentage of more common forms such as short-tailed shrews and deer mice. It is easy to understand the seasonal fluctuation in percent of katydids (*Neoconocephalus*), the only invertebrate caught, but it is more difficult to understand fluctuations in the other species, which are probably present in the environment in roughly equal proportion throughout the year (except the hibernating jumping mice). Reasons for the fluctuations in some species are suggested in the comments in the annotated list of species.

COMPARISON OF CATCH OF OWLS AND TRAPS

From October 15 to 19, 1945 the authors and Donald Kelley trapped the region around the barn occupied by the Edgmont barn owls. Presumably this was the region over which the owls hunted. Museum Special snap traps, Sherman live traps, small wire-cage live traps, and sunken tin cans were used. In 418 trap nights 171 animals were caught. They are compared in Table 2 with those caught by the owls from October 10–31. The population of deer mice indicated by trapping is perhaps high because many of them were released from the live traps and several were probably recaught. Perhaps 25 percent would be a more honest figure. In an effort to cover all kinds of habitats, much meadow land inhabited chiefly by meadow mice was not trapped thoroughly, so the indicated percentage of meadow mice is probably lower than actually occurs over the region. Recaptures probably raised the meadow mouse percentage, however, as in the case of the deer mice.

One is impressed by the difference of the catch by traps and by owls. Failure of the owls to eat any deer mice is remarkable, for they were very abundant in the woods and overflowed into the fields. It is obvious that the owls were not catching a representative sample of the small mammals available. The trapping sample should not be considered a perfect sample of the population that was present, but it is obvious that deer mice, rats, star-nosed moles, long-tailed

shrews, and flying squirrels were present, yet the owls were not catching them during this period. A long-tailed shrew did not appear in the pellets between September 22 and December 1, nor a star-nosed mole between September 22 and the end of pellet collections on January 27, nor a rat between August 12 and January 27. Flying squirrels were never caught.

To the credit of the owls, however, it must be admitted that in four years of general trapping in the county, mostly for short-tailed shrews, we caught no jumping mice, long-tailed shrews, star-nosed moles, or little short-tailed shrews. It was only after the owls had demonstrated the presence of these mammals that we were shamed into a concerted effort and managed to capture a few specimens of the first three, but no little short-tailed shrew has been captured in the county.

TABLE 2.—*Comparison of animals caught by trappers and by barn owls in the same region at the same time of year*

	TRAPPING 10/15 TO 10/19	OWLS 10/10 TO 10/31
Meadow mice	37 percent	76 percent
Deer mice	33 "	0 "
Short-tailed shrews	20 "	12 "
House mice	3 "	5 "
Rats	3 "	0 "
Star-nosed moles	2 "	0 "
Jumping mice	1 "	7 "
Long-tailed shrews	1 "	0 "
Flying squirrels	1 "	0 "
Total number of animals	171	58

WHAT BARN OWLS AT OTHER ROOSTS CATCH

A pair of barn owls living in a silo near Westtown, just over the border from Delaware County, was also studied. The farming country surrounding this silo was similar to that in which the Edgmont owls lived, possibly with less woodland close by, and it will be seen in Table 3 that the catch of the owls in the two regions was very similar.

Another barn owl lived at Secane in a more densely populated district than either Edgmont or Westtown. Its catch was studied solely by picking up bones from pellets that had disintegrated under the tree in which it had roosted. Since the skulls of some species are more fragile than others, the percentages listed in Table 3 probably are not a true representation of the catch of the owl. The high percentage of shrews probably results from the fact that the rostrum and palate of a shrew skull is much stronger than that of most mice. The Secane column in Table 3, therefore, should be considered as an indication of what species rather than of how many individuals of each species were caught.

Pellets were also collected in a hemlock grove in Lansdowne, a residential district. This owl was not positively identified, but from the size of the pellets

cast and from glimpses of the bird it was thought to be a barn owl. Some of the pellets had thoroughly disintegrated while others were intact. For the reasons mentioned above, we have listed in Table 3 the percentage of the catch as counted in the intact pellets as well as the total catch using all available bones. It will be seen that in keeping with its more urban habitat it captured a much higher percentage of rats and house mice than did the rural owls.

WHAT OTHER SPECIES OF OWLS CATCH

Long-eared owls (*Asio wilsonianus*), winter residents living at Westtown, caught a much higher percentage of meadow mice than did the Westtown barn

TABLE 3.—*Catch of owls at different roosts in percentages*

	BARN OWLS AT DIFFERENT ROOSTS						OTHER KINDS OF OWLS	
	Edgmont 8/12 to 1/27	Lansdowne 8/18 to 1/25 in pellets	Lansdowne 8/18 to 1/25 all bones	Edgmont 8/18 to 10/10	Westtown 8/16 to 10/11	Secane Undated	Westtown 12/27 Long-eared	Tinicum 12/29 and 1/9 Short-eared
Microtus	72	54	51	70	70	24	89	74
Pitymys	3	0	0	3.7	1.2	3	1.6	0
Ondatra	0	0	0.1	0	0	0	0	0
Mus	3	13	2	3.7	7.1	1	0	6
Rattus	0.2	12	29	0.4	1.2	7	0.8	14
Peromyscus	4	1	0.6	2.9	2.4	1	5.5	3
Zapus	3	2	0.5	3.7	3.6	7	0	0
Sylvilagus	0.4	0	0.2	0.8	1.2	0	0	0
Blarina	11	17	15	8	3.6	49	3	0
Sorex	0.8	0	0	0.8	1.2	0	0	0
Cryptotis	0.2	0	0	0.4	0	3	0	0
Condylura	0.4	0	0.2	0.8	0	3	0	0
Scalopus	0	0	0.1	0	0	0	0	0
Bird	0.4	0	1	0.8	2.4	0	0	3
Katydid	1.7	0	0	3.3	6	0	0	0
Total number of animals	474	99	861	245	84	95	128	35

owls or those living in nearby Edgmont (see Table 3). Eighty-nine percent of the animals eaten by the long-eared owls were meadow mice; in fact, meadow mice were represented in 98 percent of the pellets. Few deer mice and shrews were caught, and the diet was on the whole much less varied than that of the barn owls.

The pellets of the long-eared owls had a smaller diameter than those of barn owls and also contained fewer animals, averaging only 1.25 animals per pellet.

Short-eared owls (*Asio flammeus*), winter residents living in the Tinicum marshes along the Delaware River near the Philadelphia Airport, were also living principally on meadow mice (Table 3). The large percent of rats and house mice reflects the nearness of dumps and numerous habitations. As in the case of the long-eared owls, the monotony of the diet (only five species represented)

was probably due to "selection" by the owl rather than to an absence of other species.

The short-eared owl pellets were intermediate in diameter between those of long-eared and barn owls, and averaged 1.7 mice per pellet.

ANNOTATED LIST OF THE MAMMALS OF DELAWARE COUNTY

Sorex cinereus fontinalis Hollister. Long-tailed shrew.—This is one of the scarcest mammals of the county. It has been reported only by Rhoads (1903), who recorded one "swallowed by a chicken in Delaware County." The authors captured a 3.7 gram, recently lactating female on October 13, 1946, in a pile of logs in thick woods 3 miles north of Swarthmore, and a 3.1 gram non-breeding male in the swampy meadow near the barn at Edgmont on October 16. Extensive trapping from 1938 to 1941 in Chestnut Hill in adjacent Philadelphia County failed to catch any. The Edgmont and Westtown (Chester County) barn owls caught a few, never more than 3 percent of the catch, but none was eaten by the short-eared or long-eared owls.

Cryptotis parva (Say). Little short-tailed shrew.—Although Rhoads lists two from adjacent Chester County, this genus has never before been reported from Delaware County. The only specimen I have encountered was one found dead by Robert Coleman on a path in Crum Woods, Swarthmore, on October 28, 1942. Judging from the lacerated muscles under the skin, it had been killed by some predator. *Cryptotis* is notoriously reluctant to enter traps, and in many regions owls have proven to be better collectors of these shrews than trappers. The Secane barn owl caught some, and the pellets of the Edgmont barn owls contained *Cryptotis* remains in June, July and August.

Blarina brevicauda kirtlandi Bole and Moulthrop. Short-tailed shrew.—Short-tailed shrews are one of the most abundant mammals in the county and are found in almost every kind of habitat. Their numbers are not reflected accurately, however, in the owl pellets. The percentage of shrews caught by the Edgmont barn owls was for some reason far lower during most of August and September than it was earlier or later in the season.

In Figure 1 is shown an interesting comparison between the age of the shrews caught by the Edgmont barn owls at different times and the age of the shrews caught nearby in traps at corresponding times. Age was determined by tooth-wear, as described in a previous paper (Pearson, 1945). It will be seen that the shrews caught by owls were much younger, on the average, than those that entered the traps. Unfortunately it cannot be said whether the trapped shrews or the eaten shrews are more nearly a representative sample of the total wild population.

A female captured on October 17, 1945, contained several large embryos which appeared to be resorbing. This is the latest pregnancy of which we have record.

Condylura cristata cristata (Linnaeus). Star-nosed mole.—In spite of its distinctive appearance this species is unknown to most of the people of the region. A non-breeding male and female were caught on October 17, 1945, in the swampy meadow below the barn at Edgmont, and another non-breeding male on October 30 at the same place. These are the only specimens we encountered in many years of residence and trapping in Philadelphia and Delaware counties. Mrs. Robert Enders found the tail and hindquarters of one on a path in Crum Woods, Swarthmore, in 1945. None has been reported before from the county, although there is a specimen from Radnor, and one from Wallingford, in the collection of the Academy of Natural Sciences.

Star-nosed moles were captured by the Edgmont, Secane, and Lansdowne barn owls, but not by any of the others. The three trapped in October were taken within a few hundred yards of the Edgmont barn owl roost, yet these owls apparently did not eat any between September 22 and January 27. These moles made up 5 percent of the owl diet during the first three weeks of July.

Scalopus aquaticus aquaticus (Linnaeus). Common Mole.—Moles are rather common in the region. The authors dug up 15 in the lawns of Swarthmore during the summer of 1945.

It was surprising to find a trace of them in the owl diet, for they hardly ever come above the surface. That barn owls catch them occasionally is indicated by the fact that we found a single humerus under the Lansdowne roost. There is a possibility that this was the humerus of a hairy-tailed mole (*Parascalops*), a species which ventures above ground more frequently than *Scalopus*, and is more frequently found in owl pellets in regions where it occurs. *Parascalops* has never been reported near Delaware County, however.

Mustela frenata noveboracensis (Emmons). Weasel.—Weasels are found throughout the county but are nowhere abundant and were never eaten by the owls. We have no evidence of the occurrence of Bonaparte's weasel, *M.e. cicognani*, in the county.

Tamiasciurus hudsonicus loquax (Bangs). Red squirrel.—Red squirrels are rather scarce in the county. We have seen them occasionally near Swarthmore and at Glen Mills. Perhaps because of their diurnal habits they were not caught by any of the owls studied.

Tamias striatus fisheri Howell. Chipmunk.—Although they are not abundant, chipmunks are found throughout the county. They are one of the few small mammals of the region which were never captured by owls, and their immunity probably arises from the fact

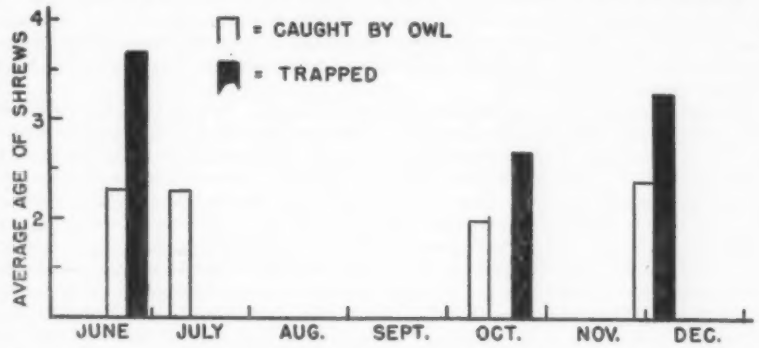

FIG. 1.—The average age of short-tailed shrews caught by the Edgmont barn owls compared with the average age of shrews trapped in the same region over the same period. Age is recorded in tooth-wear units.

that they are strictly diurnal. Contrast this fact with Audubon's well known painting of a barn owl holding a chipmunk.

Sciurus carolinensis leucotis (Gapper). Grey squirrel.—Squirrels are abundant throughout the county but were never represented in the pellets.

Glaucomys volans volans (Linnaeus). Flying squirrel.—Two flying squirrels were recovered in thirty pellets from a great-horned owl in Florida (Moore, 1946) but none was eaten by the owls we studied, in spite of the fact that flying squirrels are not scarce in the region and are abroad at the same time that the owls are hunting. In the pasture below the Edgmont barn one flying squirrel was captured more than 75 yards from the nearest tree. It is remarkable that this or some other vagrant was not captured during the whole time the owls were being studied.

Peromyscus leucopus noveboracensis (Fischer). Deer mouse.—Short-tailed shrews, meadow mice, and deer mice are the most abundant mammals in the region. Deer mice were quite abundant in 1945, while the pellets were being collected, in contrast to the winter of 1943 when they were rather scarce. Numerous young mice in grey pelage were caught between October 14 and 19, 1945, but none of ten adult females dissected was pregnant. Two were lactating, however. None of 11 males was in full breeding condition. The latest pregnancy we have encountered was that of a female with large embryos on November 6, 1942. An immature female and an adult male captured on July 29, 1939, each had a large, inguinal,

bot-fly warble. These mice were marked by clipping toes, and when recaptured a few days later they had both lost the warbles. Apparently the mice were unharmed by this parasite for they were recaptured on several later occasions. Another male captured on August 17 of the same year contained a small warble, but he was not recaptured.

The owls studied did not capture as many deer mice as would be expected. Trapping in mid-October around the Edgmont roost disclosed the presence of great numbers of deer mice, yet these owls apparently did not eat a single one between September 4 and October 31, and the long-eared owls in nearby Westtown ate less than 6 percent deer mice.

Microtus pennsylvanicus pennsylvanicus (Ord). Pennsylvania meadow mouse.—Meadow mice are fairly numerous in suitable habitats in the county. We recorded them to be not abundant in 1939 and 1940, but they were numerous in November of 1942, and again in the fall and winter of 1945–46. A litter of five was born to a recent captive on November 7, 1942, and two of 15 females examined between October 15 and 19, 1945, were pregnant. The seven embryos in one of these were probably being resorbed. Many of the October males had large testes (up to 19 mm long) and were probably in breeding condition.

Meadow mice were by far the most important item in the diet of all the owls studied. In the Tinicum marshes they are much more abundant than any other species, but in the other regions there is so much woodland and other unfavorable terrain that they certainly do not make up more than 50 percent of the small mammal population, yet they constitute a much larger percentage of the owl diet.

Pitymys pinetorum scalopsoides (Audubon and Bachman). Pine mouse.—Pine mice have not previously been reported from the county. We have, however, captured them on several occasions in the Crum Woods at Swarthmore, once in an orchard at Glen Mills, and on a few occasions in thick woods in Chestnut Hill, Philadelphia County. They were especially abundant in the spring of 1942. One line of about 30 live traps in that year along Whiskey Run, Swarthmore, caught in one day and night during March: 2 *Blarina*, 6 *Peromyscus*, and 11 *Pitymys*. Three or four of the *Pitymys* may have been caught more than once since some were released again. Also in March one almost stark naked pine mouse was caught, with only a patch of hair on its head and neck. A mouse in a somewhat similar condition was recorded by Hamilton (1938) in the spring of 1936, a year of pine mouse abundance. Four pine mice were caught in Swarthmore in the spring of 1943, but they were scarce in 1944, and none was caught during extensive trapping in the fall of 1945. The peak of abundance of pine mice came in 1942, a year when meadow mice were abundant, but pine mice were scarce in the fall of 1945 when meadow mice were abundant again. Hamilton (*op. cit.*) quotes Wharton Huber as saying that *Pitymys* was very abundant in nearby Chester County in the winter of 1935–36, but scarce in the summer and fall of 1936.

Small numbers of pine mice were caught by the Edgmont and Westtown barn owls, and by the Westtown long-eared owls. It was surprising to find that, despite the somewhat subterranean habits of these mice, they were occasionally caught in greater numbers than the much more abundant deer mice.

Clethrionomys gapperi (Vigors). Red-backed mouse.—The only record of this genus in the county was a sight record by Stuart (1926). Since he did not include *Pitymys* in his list of mammals from the county, he probably did not entertain the possibility that the mouse that he saw was a pine mouse—a more likely possibility. No red-backed mice were eaten by any of the owls.

Ondatra zibethica (Linnaeus). Muskrat.—Muskrats are common in the county, where they frequently live in quite settled communities, but they are seldom seen. Some were living in Ridley Creek a few hundred yards from the Edgmont roost, yet these owls never caught any. The only muskrat caught by any of the owls was at Lansdowne.

Mus musculus (Linnaeus). House mouse.—House mice are abundant in and around buildings. Many were trapped in the fields in October, 1945, but none in the woods. One female was carrying large embryos when caught in the fields on October 15, and the males appeared to be in breeding condition. They made up a small but regular part of the diet of the barn owls and the short-eared owls, but were not represented in the long-eared owl pellets.

Rattus norvegicus (Erxleben). Brown rat.—Rats are widespread in the county, but do not seem to be a preferred food of the owls. Only one percent of the animals eaten by the Westtown barn owls was rats, despite the fact that rats were nesting in clear view on the floor of the large silo in which these owls lived, and the great probability that they were numerous in the barnyard outside. Calculating from whole pellets dissected, the diet of the short-eared owls in the Tinicum marshes was about 14 percent rats, and 12 percent in the case of the owls in well-populated Lansdowne. (The 29 percent given in Table 3 includes skulls picked up from disintegrated pellets.) The probability that large rat skulls would survive and be recovered is greater than that of more fragile mouse skulls.

Zapus hudsonius americanus (Barton). Eastern jumping mouse.—These are seldom seen or trapped in the county. We have encountered four: one found dead at the edge of a field of beard grass (*Andropogon*) in Swarthmore, two trapped on October 15 in beard grass on a hilltop 3 miles north of Swarthmore, and one trapped on October 19 in a marshy meadow at Edgmont. Jumping mice made up as much as 7 percent of the diet of the Edgmont barn owls during the last half of October. None was captured after November 14, so it is probable that these mice went into hibernation in 1945 during the last of October or early in November.

Sylvilagus floridanus. Cottontail rabbit.—Rabbits are abundant in the county and are occasionally eaten by owls. The Edgmont barn owls captured rabbits throughout June, then no more were represented in the pellets until after August 12. None was captured after September 22. These restricted periods, as well as the condition of the rabbit bones, suggest that the owls catch only very young rabbits. Just-weaned rabbits noted on May 13 and August 11 were probably at the most vulnerable stage, whereas half-grown rabbits that were seen on October 10 were apparently too large for the barn owls to capture.

Although they are not preyed upon by owls, the following species are also found in the county:

Opossum—*Didelphis virginiana*
Skunk—*Mephitis mephitis nigra*
Mink—*Mustela vison*
Raccoon—*Procyon lotor*
Red fox—*Vulpes fulva*
Grey fox—*Urocyon cinereoargenteus*
Feral cat—*Felis domestica*
Woodchuck—*Marmota monax*
Deer—*Odocoileus virginianus*

Most of these are fairly abundant. We have never seen wild mink in the county, but some have escaped from fur farms in recent years. Nor have we seen deer, but Dr. Robert Enders tells us that they have been seen in the last few years at Swarthmore and Sycamore Mills. No bats of the region have been listed.

DISCUSSION

Several conclusions are apparent. Different species of owls hunting in the same region catch different species of animals, or catch the same species in different proportions. The owl catch is not the same as that of people trapping in the same region at the same time, nor are the ages of the shrews caught by the owls the same as those caught by trappers. Since owls catch some species (such as *Cryptotis*) that trappers miss, and fail to catch others that are present (bats, flying squirrels, deer mice), it is obvious that neither owls nor trappers catch a representative sample of the small mammal population. All these facts are in disagreement with McAtee's contention (1932) that a predatory bird captures prey animals approximately in proportion to their numbers.

If McAtee's concept of proportional representation were true, it would be possible, after determining the population density of any one species preyed upon by owls, to calculate by proportions the numbers of every other species present. Such a labor-saving method of estimating the numbers of small mam-

mals has interesting possibilities, but it must first be established which species, if any, are captured in proportion to their numbers. We have pointed out above that several species are not.

Comparing the catch of the Edgmont barn owls with that of our traps in different habitats nearby, we find the owl diet most closely matched by the traps set in the marshy meadow. Traps set in the woods caught a quite different sample than the owls. This indicates that the barn owls seldom hunted in the woods. We have seen barn owls at dusk skimming at high speeds a few feet over the grass in open fields—a type of hunting not well suited to thick woods. Judging from the large percent of meadow mice and house mice in their pellets, it appears that the long-eared and short-eared owls also hunt primarily over open fields.

Our survey of owl predation in the region is by no means complete. We do not know what the numerous screech owls catch, and we have found no pellets of the occasional snowy and great-horned owls that winter here. It is almost certain that their catch would reflect their different sizes and abilities.

Despite certain limitations such as have been pointed out above, a study of owl pellets can yield much information about the mammals of a region—and the owls do most of the work. Not only can one learn from the pellets what species are present, but, if the pellets are collected at regular intervals, one can learn such things as the approximate dates when the young of prey species are born, how many litters are born in a season, when the young become grown, and when a species enters or emerges from hibernation or estivation. Especially valuable would be data collected over a period of several years, and if the hunting range of an owl were known (such as on an island), one could calculate neatly what percentage of a prey species is captured per day.

SUMMARY

Pellets from a barn owl roost were collected at regular intervals from June until January and marked fluctuations were recorded in the percent of different species of small mammals captured. The pellets were larger in June than later in the year. It is estimated that this "family" of owls was catching more than 1.8 animals per acre per year.

The catch of these owls was quite different than that of people trapping nearby at the same time. Deer mice especially were surprisingly scarce in the pellets. On the average the owls caught younger shrews than the trappers.

Barn owls at other roosts nearby caught different kinds of animals, or the same animals in different proportions. Short-eared and long-eared owls also caught different percentages. It is concluded that owls do not catch a representative sample of the small mammal population—nor do trappers.

An annotated list of the mammals of the county is given.

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REPORT ON A COLLECTION OF MAMMAL BONES FROM ARCHEOLOGIC CAVE-SITES IN COAHUILA, MEXICO[1]

BY RAYMOND M. GILMORE

In 1940–41, Walter W. Taylor, Director of the U. S. National Museum Coahuila Expedition, excavated some prehistoric cave sites near Cuatro Cienegas in central Coahuila, Mexico (fig. 1). The collection of bones was sent to the Division of Mammals of the U. S. National Museum for identification. The fine state of preservation, clean condition, and detailed stratigraphic labeling of the bone specimens, and the lack of information on the mammals of Coahuila, have encouraged the preparation of this report to treat specifically of the mammals represented in the collection. Reference is made also to species *not* represented in the faunal debris. However, lack of recently collected Coahuila mammal specimens, especially skeletons, and the absence of a mammalian and general ecologic survey of the Cuatro Cienegas region, have caused some of the identifications and interpretations to be more haphazard than otherwise would have been the case. Remains of birds and fishes were scarce; lizards were represented by a number of complete skulls and some other bones.

This report is essentially an incomplete Recent mammal list from a specific locality at a time horizon many hundreds of years ago. The ecologic interpretations are as important as the list of species, but they are generally less definite. Information on the physical and vegetational conditions which limit the distribution of some mammal species, and the opposite conditions which give them an optimum environment, are difficult to judge or to obtain from the literature. These points are obviously important to the archeologist, especially in this case the presence or absence of permanent water.

[1] Published with the permission of the Secretary of the Smithsonian Institution.

About 100 of the 2,105 identifications of mammal bones were made by David H. Johnson, Associate Curator of Mammals, before he left for service in the U. S. Navy. These identifications have not been re-examined except in cases where subsequent developments threw doubt on the original decision, and these cases were few. In fact, all doubtful and important identifications by either of us were scrutinized several times.

FIG. 1. (map). Coahuila and adjacent region. 1. Tamaulipan biotic province of Goldman and Moore (1946, p. 349). 2. Chihuahua-Zacatecas biotic province. 3. Sierra Madre Oriental biotic province.

Cuatro Cienegas is a town in an intermontane basin, 742 m. (2434 ft.) in elevation, which contains marshes and is surrounded by the Sierra Madre Oriental (see figs. 2 and 3; also pl. 1, fig. 1). The floor of the basin is made up of gypsum sand desert and playa basins, with saline pools set in extensive marshes. In favorable places grow short grass, salt-marsh vegetation, and creosote-bush (*Larrea tridentata*). Most of this desert area may be considered as covered with the typical "creosote-bush association" of the Lower Austral (or Lower Sonoran)

Life-Zone, and its characteristic mammals are pocket-mice, kangaroo-rats, and small spotted and pygmy ground-squirrels (see Nelson and Goldman, 1926). In favorable places, especially on the margins of the flats, are groves of mesquite (*Prosopis*), with interspersed cacti.

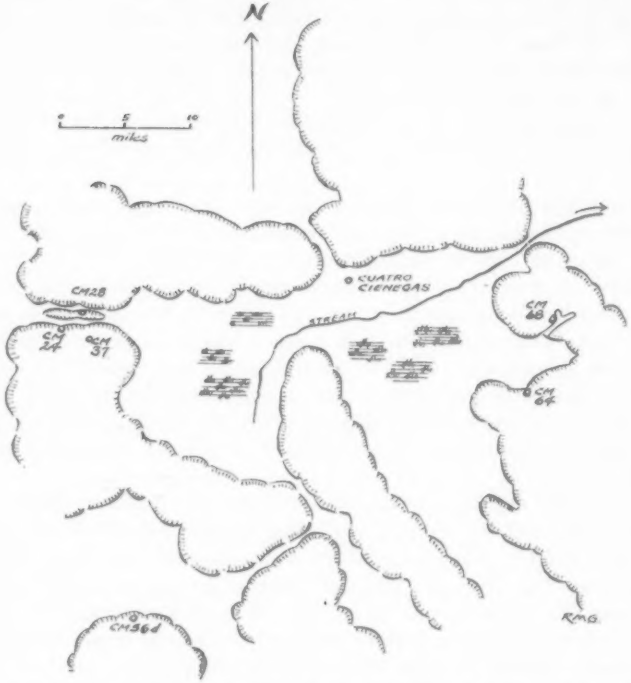

FIG. 2. (map). Cuatro Cienegas basin, showing distribution of mountains and basin, and location of archeologic cave sites, CM24, CM28, CM37, CM56d, CM64, and CM68. Redrawn from sketch of W. W. Taylor.

Fig. 3. Schematic cross-section across widest part of basin, showing distribution of geomorphology and vegetation-types. Redrawn from sketch of W. W. Taylor.

From the edges of the valley and reaching to the bases of the cliffs which rise to the surrounding mountains are pediments with "monte" vegetation consisting of grasses (probably sotol, *Dasylirion*; bear-grass, *Nolina*; and grama, *Bouteloua*), lecheguilla (*Agave lecheguilla*), yucca (*Yucca*), ocotillo (*Fouquieria*), and cacti. This marginal area may be considered also as Lower Austral with mammals

similar to those of the desert flats, but jack rabbits, cottontails, wood-rats, and quail are more numerous.

The broken cliffs and the canyons leading into the mountains are rocky with desert flora which merges through pinyon-pine (*Pinus cembroides*) and oak (*Quercus*) into yellow pine (*P. ponderosa*) on the higher summits. The pinyon-rock-association may be considered Upper Austral, and it contains some mammals different from those on the lower slopes, and also higher concentrations of some of the same kinds that are not so numerous below. Rock squirrels, cacomistles, and mule-deer probably are numerous. The pine association, at higher elevations, is considered to be of the Transition Zone, and it is characterized by some slightly to markedly different animals including bear and the white-tailed deer.

Precipitation is light at Cuatro Cienegas and is confined largely to sporadic heavy thunderstorms from July to October. Annual rainfall is in the 0–200 mm belt, but is close to the 200–400 mm belt to the east (Shreve, 1944, p. 106). Permanent water exists today as far as known only in the canyon on the north side of Cuatro Cienegas basin near the town, and also in the marshes and in the small stream which flows eastward through a gap in the mountains to join the Rio Salado, which also flows eastward, to the Rio Salinas and thence to the Rio Grande. A cool, damp fog often drifts over the eastern edge of the basin, but deposits little water. There is some evidence that some centuries ago during the period of aboriginal occupancy of the caves the climate was more humid, and water more plentiful.

The Cuatro Cienegas region is considered by Goldman and Moore (1946) to lie on the eastern edge of the extremely arid Chihuahua-Zacatecas biotic province (the Chihuahuan of Dice, 1943), near where it merges with the Tamaulipan province on the east (fig. 1, map). Although Cuatro Cienegas is on the watershed of the lower Rio Grande, and would seem to belong properly with the Tamaulipan province, the upper, eastern slopes of the Sierra Madre Oriental in this region and northward belong biotically with the province to the west on account of extreme aridity. Biotic provinces are local geographic centers of endemism resulting from the differentiation of local varieties or subspecies, or by the isolation of larger taxonomic units which once occupied a wider area (reliction). Life-zones are microclimatic belts often corresponding with altitude in mountainous areas, and are characterized by a general common plant and animal assemblage (indicators). A life-zone may extend through several biotic provinces, and conversely, a province may have several life-zones within its confines. Soil and terrain may be factors in life-zone distribution at the expense of microclimate. Minor divisions of a life-zone are "associations" which may vary somewhat by biotic provinces through slight local endemism.

The relation between natural and primitive cultural areas in North America was discussed in detail by Kroeber (1939). This study showed that, culturally, the Cuatro Cienegas region is transitional between the Southwest and Mexican centers. Kroeber gave much credit to Clark Wissler for early advocation of the ecologic framework of culture, and said, "We can accept Wissler's findings on

TABLE 1.—*List of mammals represented in cave deposits near Cuatro Cienegas. Numbers are of bone fragments*

NAME	CM31	CM37	CM56D	CM64	CM68	TOTAL
Mastiff-bat (*Eumops perotis californicus*)	—	—	—	—	1	1
Man (*Homo sapiens*). Scattered fragments only	1	—	—	—	10	11
Black bear (*Euarctos americanus*)	—	—	—	—	2	2
Grizzly bear (*Ursus*, of *planiceps* group)	—	—	—	—	1	1
Raccoon (*Procyon lotor*)	—	—	—	—	4	4
Coati (*Nasua narica*)	—	—	—	—	6	6
Cacomistle (*Bassariscus astutus*)	6	—	—	—	63	69
Badger (*Taxidea taxus*)	3	—	—	—	4	7
Hog-nosed skunk (*Conepatus mesoleucus*) (?)	—	—	—	—	3	3
Badger or hog-nosed skunk	—	—	—	—	1	1
Striped skunk (*Mephitis mephitis*)	—	—	—	—	3	3
Spotted skunk (*Spilogale leucoparia*)	2	—	—	—	6	8
Striped skunk or spotted skunk	1	—	—	—	2	3
Gray fox (*Urocyon cinereoargenteus*)	5	—	—	—	18	23
Desert fox (*Vulpes macrotis*)	1	—	—	—	1	2
Coyote (*Canis latrans*)	14	—	1	—	9	24
Coyote or dog (*Canis familiaris*) (?)	4	—	—	—	10	14
Wolf (*Canis lupus*) or dog (?)	1	—	—	—	2	3
Bobcat (*Lynx rufus*)	1	—	—	—	5	6
Puma (*Felis concolor*)	—	—	—	—	6	6
Puma or jaguar (*Felis onca*)	—	—	—	—	3	3
Rock squirrel (*Citellus variegatus*)	16	5	1	3	120	145
Mexican ground squirrel (*C. mexicanus*)	22	—	—	—	1	23
Spotted ground squirrel (*C. spilosoma*)	52	4	1	—	—	57
C. mexicana or *C. spilosoma*	1	—	—	—	—	1
Antelope ground squirrel (*Ammospermophilus interpres*)	9	—	—	—	—	9
White-throated wood-rat (*Neotoma albigula*)	238	30	1	—	32	301
N. albigula or *N. micropus*	5	—	—	—	50	55
Cotton-rat (*Sigmodon hispidus*)	2	—	—	—	—	2
Pocket-mouse (*Perognathus penicillatus*)	2	—	—	—	1	3
Pocket-mouse (*Perognathus nelsoni*)	1	—	—	—	—	1
Kangaroo-rat (*Dipodomys spectabilis*)	2	3	—	—	—	5
Pocket-gopher (*Thomomys umbrinus*)	—	—	—	—	3	3
Pocket-gopher (*Cratogeomys castanops*)	21	—	1	—	4	26
Yellow porcupine (*Erethizon epixanthum*)	—	—	—	—	42	42
Jack-rabbit (*Lepus californicus*)	117	2	14	—	44	177
Cottontail-rabbit (*Sylvilagus audubonii*)	166	8	1	—	17	192
Jack-rabbit or cottontail	—	—	—	—	2	2
Pronghorn (*Antilocapra americana*)	—	1	—	—	22	23
Mountain sheep (*Ovis canadensis*)	1	—	—	—	4	5
Mountain sheep or domestic sheep (*O. aries*) (?)	—	—	—	—	1	1
White-tailed deer (*Odocoileus virginianus*)	23	5	—	—	39	67
Mule-deer (*Odocoileus hemionus*)	1	14	6	2	75	98
White-tailed or mule-deer	18*	—	—	—	260	278
Deer or pronghorn	1	2	—	—	9	12
Elk (*Cervus canadensis*)	—	—	—	—	4	4
Bison (*Bison bison*)	1	—	—	—	8	9
Unidentified mammal bones	29	3	—	—	332	364
Total						2,105

* Includes one fragment from site CM28. No other bones were found at this site.

the relation of culture areas to environment. He (Wissler) concludes that environment does not produce a culture, but stabilizes it. Because at many points the culture must be adapted to the environment, the latter tends to hold it fast. Cultures therefore incline to change slowly once they have fitted themselves to a setting, and to enter a new environment with more difficulty than to spread over the whole of the natural area in which their form was worked out. If they do enter a new type of environment they are subject to change. Once fitted to an environment, they are likely to alter radically only through some factor profoundly affecting subsistence, such as the introduction of agriculture (*ibid*, p. 6)." Kroeber (*ibid*, p. 2) suggested a new name for a geographic and cultural unit, "diaita", to correspond to the term "biota" used by biologists.

The cave-sites, as numbered by Taylor, are CM24, CM28, CM37, CM56d, CM64, and CM68. Only CM24 and CM68 have extensive archeologic deposits and associated faunal debris. Taylor states (personal communication) that all the cave-deposits, except for a small part, are the result of human habitation. Hence, most of the animal remains were deposited through human agency, though some probably represent the natural remains of normal cave-animals that inhabited the caves during periods of occupancy and probable sporadic non-occupancy by man.

CM 24 is a small cave on the west side of Cuatro Cienegas basin, and is situated at the base of a canyon wall about 10 yards above the dry, sandy canyon-bottom (see pl. 1, fig. 1). Today it is about 10 miles from pine-timber, and water is absent except occasionally and briefly following thunderstorms with rain in the late summer and fall seasons. During aboriginal occupancy, it would seem that conditions were more humid and water more nearly permanent, and the presence of two specimens of the cotton-rat and the many specimens of pocket-gophers (*Cratogeomys*) from this site might seem to be corroborative evidence.

CM68 is a long, high and narrow cave at the base of a high cliff (pl. 1, fig. 2), and is situated at a considerable distance up a long canyon on the east side of Cuatro Cienegas basin, about 1,500 feet above the floor of the valley. It is in the Lower Austral Life-Zone, not far below the pinyon-juniper Upper Austral Life-Zone of the higher elevations, access to which is difficult because of the high cliffs that ring the canyon. Reconnaissance to date in the canyon has not disclosed any permanent water, even in potholes (*tinajas*) which usually retain seasonal water longer than a canyon-arroyo. The cool and damp fog that often drifts in from the eastward and down the canyon in front of the site, keeps the locality cooler and damper than elsewhere in the basin, but deposits little or no water. In former times, permanent water probably was present in the canyon as is indicated by the presence of cave-remains of raccoon, common and hog-nosed skunk, porcupine, and elk.

Several examples show the uncertainty and danger of misidentification inherent in this type of work. At an early stage in the identifications, several bone-fragments were provisionally determined as those of the spider-monkey (*Ateles*). Among these were portions of two ulnae, one radius, and one lumbar vertebra. Later scrutiny, however, threw grave doubt on these identifications, and although some of the bones are not identifiable as yet with certainty (one

PLATE 1

UPPER: Cuatro Cienegas basin from mouth of canyon leading from CM68, looking northwest. "Monte" in foreground. "Flats" are represented by small patches of white in the left middle foreground. Alkali and gypsum area is the broad white band in the whole middle distance. Town of Cuatro Cienegas is at right of mountain with white cloud. Cave CM24 lies in gap between clouds at left. Photo by W. W. Taylor.

LOWER: Canyon of CM68, with cave at left, looking slightly north of east. The end of the canyon is shown; pinyons occupy a higher elevation far back from the cave. Photo by W. W. Taylor.

ulna fragment may be that of a porcupine, and the lumbar vertebra may have belonged to a coati), it would seem best to refrain from listing the spider-monkey as of even questionable occurrence unless further work discloses other skeletal fragments that are definitely or suggestively those of spider-monkey. Such confirmation might indicate dispersal of the species as a pet by trade, because Vera Cruz and southeastern San Luis Potosi are the present northern limits of the range of the spider-monkey (Kellogg and Goldman, 1944: 33), and the species is associated with unbroken tropical jungle.

Another bone-fragment, composed of the broken frontals and nasals of the skull, strongly resembles that of a mink, but with equal justification can be identified as spotted skunk. The mink is not known to occur today closer than central Texas (Travis and Mason counties) a distance of about 350 miles, whereas the spotted skunk is a present day inhabitant of the rocky, desert-regions of Coahuila. However, if later findings are positively those of mink, this fragment would assume more importance as another possible bit of evidence extending the former range of that animal.

One bone fragment (distal femur) of a rabbit gave considerable trouble in identification, and was finally matched with a femur of the pygmy rabbit (*Sylvilagus idahoensis*). However, as this species is now confined to the northern "great basin" (adjacent parts of Nevada, Utah, Idaho and Oregon), and as our comparative skeletal material is insufficient to cover the complete range of individual specific variation, such an identification seems too unlikely to accept without confirmation. This bone actually may belong to the late Pleistocene *Sylvilagus leonensis* described from southern Nuevo Leon by Cushing (1945, p. 183). Ayer (1936, p. 605) also recorded a very small "*Sylvilagus audubonii*" from recent cave remains in the southern Guadalupe Mountains of extreme northwestern Texas, in which cave were found some extinct species.

Another inherent difficulty in a study of this nature is the relation between numbers of bone-fragments of each species and the interpretation of relative abundance of individuals. One semi-complete skeleton of one individual will give a large number of fragmentary or complete bones for that species, and this at first glance may appear to mean relative abundance. However, in general, many fragments of a species mean many individuals, because disassociation of bones of one individual is commoner than association.

The age of the deposits in the caves has not been determined as yet by human cultural material, and the mammal bones offer little definite evidence themselves. The apparent freshness of the bones may argue against considerable antiquity, but such a criterion is of little value in a cave site in the dry climate of this region where conditions for preservation are good. The absence of remains of European domesticated animals, as well as of associated manufactured trade goods, and even the dog for sure, may argue for at least pre-Spanish age. The presence of the elk and porcupine, now found farther to the north, also may indicate considerable age. The matter is to be settled by more archeologic work.

ACCOUNTS OF SPECIES

Eumops perotis californicus, mastiff-bat.—1 skull without mandible (CM68). This is the only bat-specimen in the entire collection. *Eumops* is generally a dweller of rock-crevices,

often on the face of a cliff. This accords with its scarcity at CM68, a high, open cave, which contained bat-guano only in the farthest recesses where human deposits were least in quantity.

Homo sapiens, man.—11 bone fragments (1 from CM24; 10 from CM68). Taylor found these bones scattered throughout the deposits. They do not represent the total number of human bones taken from the caves.

Euarctos americanus, black bear.—2 bone fragments (CM68). More fragments were anticipated because the black bear presumably was common in the pine-timbered parts of the mountains in former times. *E. a. eremicus* was described by Merriam (1904, p. 154) from the Sierra Guadalupe in southern Coahuila. It is probably rare in the region today.

Ursus, of the *planiceps* group grizzly bear.—1 doubtful fragment of fibula (CM68). *Ursus nelsoni* was described by Merriam (1914, p. 190) from Colonia Garcia, Chihuahua, with range stated as extending through the Sierra Madre from northwestern Sonora south to southern Durango. Hence, the grizzly bear should have occurred formerly in some numbers throughout the broken country around Cuatro Cienegas which is good habitat for the species. It is a formidable opponent for man, and probably is extinct in the region today.

Procyon lotor, raccoon.—4 skull fragments (CM68). These remains are important in that they may indicate the nearby presence of permanent water, and perhaps of associated cottonwood trees, at the time of their deposition. Speaking of raccoons in Texas, Bailey (1905, p. 193) said, "Coons are abundant along the margins of streams, lakes, and bays, along the coast, in marshes, or around water holes, adapting their habits to almost any condition save that of dryness. . . . It is not uncommon for coons to leave the stream where they have been hunting and travel half a mile or a mile to dens in a cliff, though otherwise they are rarely found so far from water." He continued (p. 195): "In western Texas coons are closely restricted to streams, and consequently are rare over wide intervals of dry desert country between. Along the Rio Grande, Pecos, and Devils River valleys they are especially abundant, and their dens are almost invariably located in the broken walls of cliffs and canyons." In New Mexico, Bailey (1932, p. 348) later found raccoons "common along practically every permanent stream . . . [but] not often found far from water, and in many sections of the State [they] are unknown over wide areas where water is scarce or in only scattered localities." Borell and Bryant (1942:13) found raccoons in the Big Bend area only along the waters of the Rio Grande and two tributary streams.

It seems logical to conclude that the raccoon in the arid Southwest is closely restricted to water, and that, in the Cuatro Cienegas region, cave CM68 was within a mile or less of permanent or almost permanent water during some time in the past. Today, as far as known, CM68 is situated far from such water. However, S. B. Benson of the Museum of Vertebrate Zoology, Berkeley, California, informed me recently that raccoons in arid Chihuahua and Sonora often are found many miles from fresh water. It is therefore possible that they can penetrate sporadically to the CM68 canyon in its present arid condition, especially in the "rainy" season, and that the relative scarcity of remains may justify this conclusion only.

The wide ranging raccoon is edible, makes a fine pet, and has an attractive fur. Taylor did not observe it in the region in 1940–41.

Nasua narica, coati.—6 bone fragments, 1 mandible (all from CM68). This long-nosed, long-tailed raccoon-like mammal is a Neotropical species, but it has been an inhabitant of the southern Nearctic fringe for probably several geologic periods. Taylor believed that he saw one in 1940–41 in the apparently waterless canyon of CM68. Although the coati is generally considered to be a tropical forest animal, and probably is commoner in the more humid Tamaulipan province, it may not be so closely restricted ecologically to woods or to water as is the raccoon. However, the number of remains may be indicative of regular occurrence of the species and of more humid conditions in the past. It can be used by man, as is the raccoon, for food, fur, or as a pet.

Bassariscus astutus, cacomistle.—69 bone fragments, including many parts of mandibles and maxillae (6 from CM24, 63 from CM68). This distant relative of the raccoon was a common inhabitant of the rocky areas of the Cuatro Cienegas region as it is today. Some of the bones may be those of naturally deceased individuals, as well as of those utilized by man.

The animal has an attractive fur, makes a fine pet, and probably is edible. It ranges throughout the Upper Austral zone of the arid region of the western United States and the plateau of Mexico, and generally is confined to rocky terrain.

Taxidea taxus, badger.—7 bone fragments (3 from CM24, 4 from CM68). As the badger is not normally a cave-inhabitant, and as two of the bone fragments are smoke-blackened, the presence of the remains in the caves would seem to be the result of human activity. The badger is a morose, savage animal, and ordinarily would be utilized by man for food and fur only. The range of the badger extends to Puebla in the southern table land of Mexico.

Conepatus mesoleucus, hog-nosed skunk.—3 bone fragments (CM68). None of these fragments is absolutely diagnostic of the species, but as the hog-nosed skunk should be a normal inhabitant of the pine and rock associations adjacent to CM68, it is reasonable to conclude that the species was present. Remains of this skunk, as well as of the following two species, may be those of normal cave inhabitants during human occupancy.

Mephitis mephitis, striped skunk.—3 skull fragments (CM68). Both this species and the hog-nosed skunk have been found associated only with stream-bed or riparian associations in the Davis Mountains of Trans-Pecos, Texas, by Blair (1940). This may be indicative of a certain amount of dependence on water in arid regions, and the CM68 specimens, with the other evidences, may indicate permanent water nearby at the time of cave-deposition.

Spilogale leucoparia, spotted skunk.—8 bone fragments (2 from CM24, 6 from CM68). This species is a normal denizen of rocks and caves, and its presence, in greater numbers than the hog-nosed or common skunks, is probably natural.

Urocyon cinereoargenteus, gray fox.—23 bone fragments (5 from CM24, 18 from CM68). "The gray fox is common over all of the western half of Texas, except on the open plains. It is mainly an inhabitant of the timbered or brushy country, living in hollow trees or logs, but preferably in dens among the rocks" (Bailey, 1905, p. 180). This ecologic distribution may account for the greater abundance of the species at CM68 far up a rocky canyon than at CM24, which is near the desert flats. The gray fox has a utilizable fur.

Vulpes macrotis, desert fox.—2 bone fragments (1 each from CM24 and CM68). Rarity of remains of this desert animal, not a cave inhabitant, is not significant.

Canis latrans, coyote.—24 bone fragments (14 from CM24, 1 from CM56d, 9 from CM68). These remains are identical with coyote skeletal material used in comparison. The coyote can be utilized by man for fur, food and also as a pet.

Canis lupus, wolf.—3 bone fragments, 1 a fragment of P^4 (1 from CM24, 2 from CM68). These specimens are much too large for coyote, and thus may be those of wolf or possibly dog. Probably they are wolf, because if Indian dogs had been present, their remains should be common and identifiable, which is not the case. Both the wolf and coyote range too widely for any ecologic interpretation to be drawn from their presence.

Lynx rufus, bobcat.—6 bone fragments (1 from CM24, 5 from CM68). These specimens are definitely those of bobcat, and not ocelot (*Felis pardalis*), a Neotropical form. Remains of bobcat are to be expected from the cave-deposits of Cuatro Cienegas because today the animal often is found in rocky terrain. Human usage of the species includes fur and possibly food. The animal ranges far from water.

Felis concolor, puma.—6 bone fragments (CM68). The puma is often a cave inhabitant, and in addition may have been a desired trophy animal. It is a poor indicator of environment, being widely distributed ecologically and geographically.

Felis onca, jaguar.—3 phalanges (CM68). The occasional occurrence today of the jaguar in the region indicates that it was probably present during the deposition of the cave-debris, though the identification of the above bones is not certain. They may be puma.

Citellus variegatus, rock squirrel.—145 bone fragments (16 from CM24, 5 from CM27, 1 from CM56d, 3 from CM64, 120 from CM68). This large terrestrial squirrel undoubtedly was a common inhabitant of the rocks and cliffs of this region, especially in the oak-pinyon-juniper associations. Taylor saw many of them in 1940–41. The preponderance of bony remains from CM68 is indicative of the better habitat for the squirrels there than near the other caves, and is correlative with longer human occupancy. This species is the fifth most com-

mon in the excavations. Its abundance, together with its size (1 to 2 lbs.) and palatability, render it a good source of food, and it could have been a minor staple-food of the region.

Citellus mexicanus, Mexican ground squirrel.—23 bone fragments (22 from CM24, 1 from CM68). Remains of this small, spotted, ground-burrowing squirrel are almost exclusively from CM24, a fact which may be correlated with the preponderance there of the animal's preferred habitat of sandy soil, grass, and mesquite association, as compared with CM68. The range of *mexicanus* as outlined by Howell (1938, p. 120, fig. 10) almost includes Cuatro Cienegas on its western border, and shows the squirrel as an inhabitant of the more humid Tamaulipan province to the east. If the squirrel does not occur at Cuatro Cienegas today, a fact not confirmable or deniable by the expedition, the presence of the cave-remains would indicate that the range has diminished toward the east, and that the probable cause is progressive aridity of the Cuatro Cienegas region. However, a mammal survey of the Cuatro Cienegas area may disclose *C. mexicanus* to be a common inhabitant today.

Citellus spilosoma, spotted ground squirrel.—57 bone fragments (52 from CM24, 4 from CM37, 1 from CM56d). The cave distribution is similar to that of *C. mexicanus*. Howell's map of the present distribution of *C. spilosoma* (1938, p. 123, fig. 11) does not include the Cuatro Cienegas region, but this is not significant because the mapped range does include areas in southwestern Coahuila, and other areas to the east of the Rio Grande. Absence of collected specimens from the Cuatro Cienegas region is probably responsible for this lacuna. Bones of *C. spilosoma* generally are distinguished by their smaller size from bones of the same age of *C. mexicanus*. In addition, the antero-interanal cusp of M_1 is slightly larger than the external one in *mexicanus*, whereas they are equal in *spilosoma*.

Ammospermophilus interpres, antelope ground squirrel.—9 bone fragments (CM24). The significance of the presence of this small squirrel in cave CM24 exclusively is not clear, as the animal ranges rather widely from creosote-bush flats to rocky canyons (Borell and Bryant, 1942, p. 21). This species is smaller even than *C. spilosoma*. Revival of the generic name *Ammospermophilus* for these small, chipmunk-like ground squirrels is based on the evidence submitted by Bryant (1945, pp. 374–375).

The smaller ground squirrels are important food sources for predators and man because they are numerous and easy to capture.

Neotoma albigula, wood rat.—301 bone fragments, including many skulls and mandibles (238 from CM24, 30 from CM37, 1 from CM56d, 32 from CM68). There are many wood rat specimens in the cave debris, and most of these have been identified as *albigula* on the basis of skull and mandibular fragments with teeth. This rat is a typical inhabitant of the extremely arid Chihuahua-Zacatecas province (Goldman, 1910, p. 32; Goldman and Moore, 1946, p. 349). However, *N. micropus* probably is represented also, although it is typically a representative of the more humid Tamaulipan province (*idem*).

N. albigula is often a "rock-rat", whereas *N. micropus* is generally an inhabitant of wood and brush. Bailey reported (1905, p. 114) that both species occur side by side at El Paso and other localities, but each retains its distinctive characters and habits, *micropus* living mainly in its stick houses in the brush, and *albigula* always keeping among the rocks along cliffs and gulches. For the Big Bend region, Borell and Bryant (1942, pp. 35–36) found that *micropus* occurred in mesquite, catclaw and cactus, while *albigula* was found in brush and near *Agave lecheguilla*. Blair (1940, p. 32) indicated that for the Davis Mountains of Trans-Pecos Texas, *micropus* is definitely a brush rat, while *albigula* was taken in rocks and grass.

Most of the Cuatro Cienegas specimens came from CM24, although more were expected from the rocky canyon environment of CM68. The degree of tolerance of these wood rats to the absence of water is high. The species is palatable to predators and man, but small.

Sigmodon hispidus, cotton rat.—2 mandibles with teeth (CM24). The presence of this species at CM24 may indicate that there existed a grassy area at marsh or stream-bank, and thus permanent water at the time of the deposition of the bones, although two mandibles are too few for positive conclusions. Bailey (1905, p. 117) stated that in west Texas, the cotton-rats were found along "the more fertile stream valleys." In New Mexico, the species had a range "continuous along the river and stream valleys" although some colonies were found on

hill-slopes (presumably in suitable grassy association) (Bailey, 1932, p. 167). Blair (1940, pp. 15, 32) found this cotton-rat common in the Davis Mountains of Texas, in the "riparian-meadow association." All these occurrences connote the nearby presence of water, although at times and places, the cotton-rat may range far from water and grassy habitat.

Perognathus penicillatus, desert pocket mouse.—3 bone specimens, including a dessicated individual, and a braincase (2 from CM24, 1 from CM68). Bailey stated for the species in west Texas (1905, p. 139): "While they are evidently partial to valley bottoms, the one essential for their burrows is a bit of mellow soil which may be found among broken boulders or between thin strata of limestone, as well as on the sandy flats, or in the soft mesa soil that collects around the base of desert bushes." Borell and Bryant (1942, p. 25) stated that "It was plentiful in the river bottom and in every wash and sandy area up to about 3500 feet elevation." This species is evidently typical of sandy desert areas in the Lower Austral zone where soft soil occurs.

Perognathus nelsoni, Nelson pocket mouse.—1 nearly complete skull (CM24). Bailey (1905, p. 139) found this species to inhabit similar places as *P. penicillatus* in western Texas, but Borel land Bryant (1945, p. 26), writing of theBig Bend area, found that "in general the habitats of the two were not the same. This pocket mouse [*nelsoni*] inhabited hard, rocky areas which were occasionally overgrown with grass, sotol, and bear grass."

Dipodomys spectabilis, bannertail kangaroo rat.—5 bone fragments (2 from CM24, 3 from CM37). This animal is a typical inhabitant of arid mesas and hillslopes with loose gravelly soil; it avoids fine sand. Scarcity of remains do not indicate its usual importance as a source of food for predators. It is highly palatable to man also.

Thomomys umbrinus, pocket gopher.—2 bone fragments, including 1 skull and 1 mandible. The presence of this species is not significant; "they live in scant stony soil" (Bailey, 1905, p. 135). The remains may have been brought to the cave by a predatory bird or mammal. Generally, pocket gophers are difficult to cpapture by man, though probing of the burrows may have been a common diverting activity, and occasionally profitable in yielding a victim. E. A. Goldman has informed me that Mexican natives catch pocket-gophers today by a noose held at the burrow-opening and eat the victims.

Cratogeomys castanops, pocket gopher.—26 bone fragments, including many skull fragments (21 from CM24, 1 from CM56d, 4 from CM68). This species inhabits soft, sandy or loamy, fertile soils of the Lower Austral zone. Bailey (1932, p. 243) stated that in New Mexico "they avoid the hard soil of the arid mesas and the upper slopes but extend their range as far as possible along the valleys and side streams, which furnish moisture and fertility." Blair (1940, pp. 27-28) found them in grassy associations in the Davis Mountains of northwestern Texas, and "most abundant where the association was found on stream terraces." Borell and Bryant (1945, p. 23) found them common along the Rio Grande in the Big Bend region "throughout the sandy-loam river bottom, but . . . absent in the dry rocky soil away from the river." The abundance of remains at CM24 may signify former permanent water or permanently damp soil nearby. Several fragments are smoke-blackened and indicate human usage for food. The animal is large enough (a half pound or more) to form a tasty food-item for man, and is not too difficult to capture in its burrows in soft soil.

Erethizon dorsatum epixanthum, yellow porcupine.—42 bone fragments, including many skull parts and mandibles. The porcupine is palatable, and is one of the easiest of mammals to capture by man. It is also of an appropriately utilizable size, averaging 15 to 20 lbs. in weight (Seton, 1929, vol. 4, p. 605). The quills were used by many North American Indians to decorate buckskin garments. The yellow procupine, although partial to rocky locations in high or cold pine-timbered regions (white pine, lodgepole pine, yellow pine), also is found in warmer areas timbered with pinyon and juniper, and sometimes even away from these. The exclusiveness and number of remains from cave CM68 reflects the rocky surroundings and proximity to the pine timber of the higher parts of the mountains.

Noteworthy from the zoologic angle is the fact that in the Recent geologic epoch, the yellow porcupine has not been recorded south of Alpine, which is just south of the Davis Mountains in Trans-Pecos Texas. Even there it is rare and probably is confined to the higher

elevations as it is in Culberson County, a little to the northwest (see Bailey, 1905; Davis and Robertson, 1944, p. 271). New Mexico is the present southern limit of abundance, and here it is "often as common in the nut pine [pinyon] and juniper areas as in the heavily timbered mountains" (Bailey, 1932, p. 223). It is possible that a biological survey of the Carmen Mountains and even of the Cuatro Cienegas region, will show the porcupine to be an uncommon inhabitant there today, although Stanley P. Young, who recently visited the Del Carmens on a study of the mountain lion, informed me that he saw no sign of porucupine there.

The indicated progressive southern extinction seems to have been natural, because there is no reason to assume extermination by man in such apparently favorable habitats and where human population is so scanty as in the Carmen and Burro mountains of northern Coahuila. However, both natural and human agencies may have been operative in extinction. A "single mandible of an immature porcupine" was found among the remains of thousands of individuals of many other mammals (including rodents) in the "late Pleistocene" deposits of the San Josecito Cave, near Aramberri, southern Nuevo Leon (Cushing, 1946, p. 185). This suggests that the porcupine was rare there at that time and that the range has oscillated considerably along its southern edge in the last 25,000 years or so, probably on account of shifts of climatic conditions and flora.

The remains are distributed throughout all the levels of deposition of cave CM68, although with progressive diminution from lower to upper levels. The time of possible extinction in the region is impossible to judge. However, the large numbers of remains from CM68 would indicate a time of deposition considerably prior to extinction, and may indicate that at that time there existed slightly lower temperature, slightly more rainfall, and more extensive pine forests.

It is conceded generally that animals change less rapidly in habit and structure than the environment, and currently seek their optimum environment. Even plants, with their immobility, are considered less rapidly plastic than environment. Hence, relatively rapid species changes in fauna imply similar changes in flora, and both are conceded to indicate changes in the environment—changes which were too sustained and rapid for adaptation to meet successfully.

The ancestors of the North American porcupine came originally from South America, effecting occupation of North America in post-Pliocene times (Scott, 1937, pp. 131–132). The genus *Erethizon* is found in North America only, probably evolving *in situ*, and in Pleistocene times became concomitantly a boreal adaptive. As such is would seem likely to remain until extinction.

Similar southern extinction in Mexico has taken place "recently" with the elk, the marmot (*Marmota* sp. ?), and bog-lemming (*Synaptomys cooperi*) (Cushing, 1946), and probably with other species. This is a phenomenon which appears to be worthy of detailed study.

Lepus californicus, black-tailed jack rabbit.—177 bone fragments (117 from CM24, 2 from CM37, 14 from CM56d, 44 from CM68). Jack rabbit remains are the third most common in the caves. The great preponderance from CM24 reflects the more ideal habitat of brushy, sandy flats near this cave than in the rocky canyon of CM68. Jack rabbits are quite independent of permanent water, metabolizing water from vegetation or obtaining it in the form of dew. The species is an important small mammal source of food for predator and man; individuals weigh from 5 to 8 lbs. (Seton, 1929, vol. 4, p. 736).

Sylvilagus audubonii, Audubon cottontail.—192 bone fragments (166 from CM24, 8 from CM37, 1 from CM56d, 17 from CM68). This species was also very common around CM24, which is in accordance with the proximity to ideal grassy and brushy habitat. This cottontail is as independent of permanent water as is the jack rabbit, and is almost as important a source of food for predator and man, weighing from 2 to 3 lbs. (Seton, 1929, vol. 4, p. 782).

Identification of these bones as *audubonii* was made on the basis of general geography, ecology and size. *S. floridanus* ranges to the Sierra Madre of Coahuila from the eastern United States, but is more a forest and thicket rabbit than is *audubonii* which prefers the more open arid country and is confined to southwestern Nearctica. *S. nuttallii* ranges south

in the Rocky Mountain region as far only as central New Mexico and Arizona. *S. audubonii* is slightly the largest and *S. nuttallii* slightly the smallest of the three species, but quantitive as well as qualitative studies of skeletons could not be made because of lack of comparative material.

Bones of the cottontail usually are distinguished readily by their smaller size from those of the jack rabbit of the same age as indicated by epiphyseal closures.

Antilocapra americana, pronghorn.—23 bone fragments (1 from CM37, 22 from CM68). The pronghorn is a fleet animal of the flat, open country, and is difficult to capture by chase or stalk, although its inordinate curiosity often leads it into danger. The preponderance of remains at CM68, which is far up a rocky canyon where fewer pronghorns are expected to occur than on the floor of the basin, may be explainable by the greater ease of ambushing stray individuals there by predator or man. The range of the pronghorn extended south to about 21 degrees N. in the central arid table-land of Mexico in the 16th century (Nelson, 1925, fig. 1).

Ovis canadensis, mountain sheep.—5 bone fragments, including 3 teeth (1 from CM24, 4 from CM68). Mountain sheep inhabit the Carmen and Guadalupe mountains today (Stanley P. Young and E. A. Goldman, personal communications). Their remains in the caves may indicate mammalian predator activity or extensive and skilled hunting by the early human inhabitants, although the species often takes refuge in caves. In the desert-mountain ranges, mountain sheep are concentrated around water holes, but in this region these individuals might have lived far back in the mountains above Cuatro Cienegas.

Odocoileus virginianus, white-tailed deer.—67 bone fragments (23 from CM24, 5 from CM37, 39 from CM68). These are considered quite positive identifications, and probably many other fragments of this species are in the group identified only as "deer." Identification of the white-tailed deer, as distinct from the mule deer, is difficult unless the specimen is a mandibular symphysis or almost complete antler. The species is not a cave dweller; it inhabits the high, brushy and rocky areas in preference to the more open, lower places. Evidently both CM24 and CM68 were close enough to the higher elevations to make white-tails available to the human cave inhabitants. Borell and Bryant (1942, p. 42) stated that "white-tailed deer or flagtail are plentiful throughout the Chisos Mountains [Big Bend region of Texas, about 200 miles north of Cuatro Cienegas] above 4500 feet elevation. They occasionally range down to 3500 feet. . . . They favor the canyons and steep slopes of the Upper Sonoran and Transition life zones where junipers, piñons, several species of oaks, and brush, afford dense shelter."

Odocoileus hemionus, mule deer.—98 bone fragments (1 from CM24, 14 from CM37, 6 from CM64, 75 from CM68). This species, like the white-tailed deer, probably was common in the region during the deposition of the cave-deposits. It was evidently commonest around CM68, and rare around CM24, even though the latter cave is at a lower altitude and nearer open country, which the mule deer prefer. However, presumably the open country near CM24 was too arid and of too purely a desert character to be entirely suitable. Borell and Bryant (1942, p. 41), reporting on the mammals of the Big Bend area of Texas, stated that the mule deer "ranges from about 2500 feet up to 5000 feet elevation, but is most abundant on the mesas and slopes between 3000 and 4000 feet. Between these elevations, grass, sotol, yucca, and several kinds of brush furnish food and shelter. The upper range of the mule deer overlaps the lower range of the white-tailed deer. The whitetail usually selects the rough, brushy habitats, whereas the mule deer favors more open areas, and its favorite habitat appears to be at the head of a draw which supports a good stand of sotol and grass."

Cervus canadensis, elk.—4 bone specimens, including 3 teeth (CM68, bottom level). The former occurrence of the elk in the Cuatro Cienegas region is a distinct surprise. The usual historic records, and specimens, do not place the elk farther south than extreme northern Chihuahua at the New Mexican border (Bailey, 1932, p. 88, map) and extreme northeastern Sonora (Mearns, 1907, p. 213). However, Nelson (1925, pp. 1-2), citing "Torquemada's Monarquia Indiana (vol. 1, book 5, pp. 611-612)" for references to the antelope, quoted a "great hunt made in honor of the viceroy . . . . in 1549 . . . . in the extreme south-

western part of the State of Hidalgo and adjoining parts of the State of Mexico . . . . [at a place] known from that day to the present as the Llano de Cazadero . . . ." At this hunt, besides many deer and a number of antelope, were taken some "large stags", which, when now considered with the specifically mentioned deer and antelope, probably were elk. This is borne out by references in the obscure publication of Ignacio de Armas (1888, pp. 75–76), who quoted the following early Spanish authors as listing in Mexico a large "ciervo" like the *Cervus elaphus* of Spain (the European elk, or red deer).

Hernandez mentioned "aculliame" (singular "aculliatl") with form and size like the Spanish elk (Ignacio de Armas considered this the moose, *Alces*, which does not seem justified). Alcedo described a large deer from "Nuevo Mejico" as "alanes (*Cervus alces*)" which was surely elk and not moose (although considered such by Ignacio de Armas). Torquemada (Monarquia Indiana, book 14, p. 41) listed large deer called "ciervos" in the "cordillera de Malpaises, y Cerros Bajos". Torquemada also mentioned deer "like the proper and natural elk of Spain" in the "sierras de Perote y de Maltrata". Torquemada (book 5, p. 12) mentioned a viceroy's hunt in Durango, at Otomies, between "Xilotepec y San Juan del Rio", where many large elk of Spain were captured with 600 deer (this is probably a different viceroy's hunt than the one quoted above by Nelson from Torquemada).

Bailey (1932, p. 42) quoted Humboldt to the effect that Montezuma showed to companions of Cortez some enormous stag antlers which Humboldt thought might have come from Monterey, California (*Cervus nannoides*, the tule elk), but which Bailey thought were probably obtained from southern New Mexico. More probably these antlers (certainly those of elk) came from central eastern Mexico not far from Mexico City.

These references, together with the Cuatro Cienegas specimens, indicate the certain former presence of the elk in Mexico in historic and protohistoric times. However, extinction in Mexico must have been rapid following the 16th century, and the elk may be presumed to have been scarce even then; late historic records are not known to me.

On the above dating of the elk in Mexico, the specimens from Cuatro Cienegas, cave CM68, probably do not indicate considerable antiquity, although they came from the lowest levels of the cave. However, they may contribute to the general evidence of former slightly greater rainfall and lower temperature in the region during deposition of the archeological material. The elk is not speleophilic, and the cave remains should be the result of predator or human activity. The specimens are deposited with the U. S. National Museum, Division of Mammals.

Bison bison, bison.—8 bone fragments (1 from CM24, 7 from CM68). Some of these specimens are questionably referred to bison. The bison ranged into Mexico, at least as far as 25 degrees N. at the time of the Spanish discovery (Allen, 1876, p. 129), and Montezuma had in his menagerie at least one individual that Hornaday said must have come from Coahuila (Hornaday, 1889, p. 373, quoting Antonio de Solis, Historia de la Conquista de Mexico, 1684, ed. 1724).

CERTAIN MAMMALS ABSENT FROM THE CAVE SITES

The absence of certain mammals from archeologic sites is often as interesting as the presence of others. This absence of remains may mean unimportance of the species to the aborigines or deliberate avoidance by them, or it may mean complete absence from the region at the time of deposition of the archeologic material. The concluded absence of a certain species from a region *can* be interpreted as meaning absence of some one or several factors that are associated with the optimum conditions under which that species lives. This has been stated in Liebig's law of the minimum, developed into the law of tolerance by Shelford (1913, p. 303).

In the following account, only the most important cave "absentees" will be discussed.

Didelphis marsupialis, opossum.—This species was included in a provisional list of mammals likely to occur in the Cuatro Cienegas region. However, their remains were absent from the cave sites, and no opossums were seen by Taylor in 1940–41. Probably the aridity of the region is and was too extreme. Had the species been present, its remains quite cer-

tainly would be represented, because the animal is of an appropriate size (6 to 10 lbs.) for food, and is easy to capture.

Dasypus novemcinctus, nine-banded armadillo.—As with the opossum, and for the similar reason of extreme aridity, this species was not found. In southwestern Texas, Bailey (1905, p. 54) noted the occurrence of the species in the semi-arid "Lower Sonoran Zone", but not "to any extent into the extremely arid region west of the Pecos." The armadillo since then has extended its range eastward to the Mississippi, but has not penetrated farther into the extremely arid regions to the west (see Kalmbach, 1943, p. 5, fig. 1).

This animal where it is found is a more prized food item than the opossum, and is as easy to capture. Absence of its remains, which include such characteristic hard parts as the carapace and distinctive bones, is good evidence of complete absence of the species from the region.

Canis familiaris, dog.—There are no definitely identified remains of dog. Some bones are listed as "coyote or dog", or "wolf or dog", but these probably should be coyote and wolf respectively, because if dog had been present, good specimens should have been found.

Felis pardalis, ocelot.—This tropical cat has penetrated into the southern fringes of Nearctica, but it is not common there and its absence from the cave sites does not mean necessarily absence from the arid Cuatro Cienegas region.

Cynomys mexicanus, Mexican prairie-dog.—It was hoped that remains of this species, now restricted to a small area of southern Coahuila and northern San Luis Potosi, would be found. Then, perhaps, an explanation could be given for its present isolated range. The species is colonial and highly palatable, and absence of remains should indicate absence from the region during the time of cave deposition. This may mean, if suitable, open, grassy habitat exists around Cuatro Cienegas, that *C. mexicanus* long has been separated from its nearest relative, *C. ludovicianus*, or that former contact was once to the eastward of Cuatro Cienegas. *C. ludovicianus* now is not found south of latitude 30, some 250 miles north of the range of *C. mexicanus*.

Tayassu angulatus, collared peccary.—The absence of remains of the peccary should indicate absence from the region during cave occupation, as is the case today. Taylor found no evidence of it in 1940–41. The animal is prized for food and hide where found, and also makes a good pet when young.

Such absence is explainable on the basis of extreme aridity, as is the case with the absence of the opossum and the nine-banded armadillo, even though peccary habitat of brush and oak-thicket is present. Bailey (1905, p. 55) showed that the distribution of the peccary in Texas did not include the arid region west of the Pecos, nor did it include the arid, grassy Staked Plains. Borell and Bryant (1942, p. 39) showed that the peccaries were found in a few places in the Big Bend region west of the Pecos, although much desirable habitat there was uninhabited by them. Nevertheless, it seems clear that the peccary is not tolerant of extremely arid conditions, and hence probably is absent from most of the Chihuahua-Zacatecas province. This would account for its absence from the Cuatro Cienegas region.

European domesticated mammals (sheep, goat, horse, pig). No definite remains of any of these mammals were found in the cave debris. This may be good evidence for the pre-Columbian age of the sites. One doubtful bone of sheep was found, but this is not conclusive. Taylor states verbally that in the last few years, goats have been stabled in the CM68-cave. However, they left no bony remains on the surface.

SUMMARY

A total of 2105 mammal bone fragments, collected by the U. S. National Museum Coahuila Expedition, were examined from several cave sites in Cuatro Cienegas. Of these, 1746 were identified as belonging to 39 species. Most of these species are utilizable as food by humans; some are also natural cave-inhabitants; others may be adventitious as archeologic cave specimens. The most important human food species appear to have been the mule and white-

tailed deer, followed by cottontails and jack rabbits, and the rock and spotted squirrels. Antelope, mountain-sheep, bison, and elk were present, perhaps in numbers, although their remains are relatively scarce. The large number of remains of wood rat probably means some degree of former human utilization, together with some extent of natural occurrence as cave inhabitants in the absence (or even presence) of man. The remains of the cacomistle may be judged similarly. Many bones are in a fine state of preservation, even with tendons adhering, but this, because of the generally favorable condition for preservation in caves in the arid "southwest", may not mean recent age (less than 500 years or so). Nothing in the faunal debris suggests anything more than moderate antiquity.

Noteworthy occurrences of mammal species are those of the elk and the yellow porcupine. Neither species has been recorded hitherto so far south, and both appear to have become extinct in northern Mexico within the last 500 years or so. This local, progressive southern extinction of the elk, procupine, and some other mammals is a recent phenomenon. It appears to have been natural, and presents a problem worthy of more investigations.

Unexpected absences are those of the opossum, armadillo, Mexican prairie-dog, and especially the collared peccary and the dog. The absence of European domesticated mammals indicates a pre-Spanish contact date for the aboriginal human occupancy. The absence of the collared peccary is a problem in itself for further study; the apparent reason of extreme aridity may not be as good as supposed.

Certain differences in species occurrence and species abundance, according to cave sites, may be explainable on the different conditions that immediately surround each cave. Thus, CM24, near the floor of the basin, had a greater number (some exclusively) of purely desert mammals which frequent cactus-creosote bush-mesquite-grass-sand areas, *e.g.*, jack rabbits, cottontails, desert wood-rats, small ground-squirrels, pocket mice, kangaroo rats, and the pocket gopher (*Cratogeomys*). On the other hand, CM68, far up the head of a rocky canyon, had a greater number of rock, brush and timber inhabiting species (some exclusively), *e.g.*, cacomistle, spotted skunk, gray fox, rock squirrel, porcupine, mountain sheep, deer, and elk. Some of these differences, however, may be the result also of the facts that CM68 is a larger cave with much more debris than CM24, and probably was inhabited by humans longer. Biotic conditions around cave CM68, in conjunction with its large size, appear to have favored the locality for human residence over the other caves excavated in the region.

There is some faunal evidence that the climate was more humid during deposition of the cave debris than it is today. The striped and hog-nosed skunks, and especially the raccoon and cotton-rat, suggest the presence of permanent water near the caves. The porcupine and the elk suggest slightly lower temperatures and perhaps more humidity. On the other hand, the absence of the opossum, armadillo and the peccary indicate that former conditions were as unfavorably dry for these animals as are conditions today. Furthermore, the

porcupine and elk may have been relict survivors long after the climate had approximated its present condition. Finally, lack of a present day mammal and ecologic survey of the region makes any of the interpretations risky.

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CRICETINE RODENTS ALLIED TO PHYLLOTIS

BY WILFRED H. OSGOOD

Classification of the cricetine rodents of South America encounters unusual difficulties. Knowledge of them has been acquired piecemeal over a long period and some past mistakes still trouble the present. Both specific and generic names have been applied rather freely on the basis of characters which at one time seemed sufficient but which become increasingly unsatisfactory as connecting forms continue to be discovered. Oldfield Thomas, who is responsible for most of the names and for preliminary attempts at natural groupings, seldom had large series of specimens from contiguous regions and he was not much given to synthesis. The high degree of differentiation which may exist notwithstanding complete intergradation was not often evident to him and, at least in some cases, characters thought to be generic have proved to be scarcely more than subspecific. On the other hand, there was considerable justification for the divisions made by Thomas and others, since the morphological differences observed in limited and scattered material were often such as elsewhere had proved to be diagnostic and unconnected. As more and more material is studied it becomes evident that standards established for older faunas in other continents fail in South America.

These cricetines entered South America from the north, some of them apparently in late Pliocene and a greater number doubtless in middle or late Pleistocene, some probably in comparatively recent times. Those which differ most from existing northern forms may be assumed to have had a longer residence and lineage in the south, but all are so closely interconnected that many individual cases are very puzzling and probably cannot be clearly understood until or unless paleontological evidence greatly exceeds what is now available. A common experience with recent workers is to find species that combine the characters of two, three, or more supposed genera long recognized and apparently well characterized. The disposition of such species thus becomes a problem.

It is small wonder that Ellerman (Fam. and Gen. Rodents, vol. 2, p. 327, 1943) should speak of this group as being in an "appalling chaos" and further (p. 328) say "The task of arranging these in any natural order is almost impossible."

Fossil rodents allied to or directly assignable to the Cricetinae are known from the Tertiary of both North America and Eurasia, dating back to Lower Oligocene. The direction of any interchange during early periods may not be demonstrable, but the group in Europe and Asia is now greatly reduced, whereas in North America it is flourishing. In the Old World it was subjected to the competition of the Murinae, a large, varied, and aggressive group having ecological preferences similar to its own. Hence its success was limited and temporary. Today it is represented in the Old World only by the hamsters (*Cricetus* et al.) and by a single monotypic genus (*Calomyscus*), very limited in distribution, and doubtless on its way to disappearance. This last is so similar to the American *Peromyscus* that it probably signifies a late Pleistocene invasion from North America. This may have been of small proportions but it was obviously unsuccessful.

Very different results ensued when the North American cricetids spread southward. In South America they found a large highly diversified continent offering most favorable conditions for rapid radiation and differentiation. The histricomorphs, which had preceded them, were mostly too specialized to stem the invaders and, as compared to the Murinae, were almost negligible. As mentioned elsewhere (Mamms. Chile, p. 35, 1943) the dominance of the cricetids is now far advanced and such competition as still exists indicates the early crowding out of the smaller octodonts.

A possible explanation of the present situation is easily derived as a result of these conditions. The considerable diversity shown by the southern cricetids is probably due first to persistence of ancestral characters laid down in the north prior to any southern movement and second to the comparative lack of competition and the wide choice of habitat suddenly opened to colonization. Most of the octodonts were of relatively large size and unable to occupy many ecological areas which the generalized cricetids welcomed and rapidly over-ran. Isolation and consequent differentiation were relatively easy, but frequently incomplete as indicated by numerous existing gradations between genera or pseudogenera. This is perhaps due partly to the rapidity of the movement and partly to uninterrupted favorable conditions in intervening areas. Such conditions may have been long continued, but it is evident that successive incursions covered large areas in a very short time. This is shown by some members of the genus *Oryzomys* which now range from Panama to Tierra del Fuego with comparatively little differentiation. Doubtless even more rapid has been the spread of certain birds as instanced in the case of *Zonotrichia capensis* (see Chapman, Bull. Amer. Mus. Nat. Hist., vol. 77, pp. 381–438, 1940).

As often remarked, classification, as we know it, would be quite impractical if a complete series of ancestral types were available. Possibly something of the kind is involved here, for it seems probable that in some of these South American cricetids we have an illustration of a stage in the development of a new fauna showing conditions which usually have been obliterated elsewhere. Just as paleontologists have found it necessary to increase the number of their categories

of classification, it appears that students of recent faunas, not only in this case, but in others where knowledge has increased, should do the same. One of the simplest steps in this direction is to recognize by subgeneric names the natural divisions within the genus.

Even primary divisions of these rodents are not wholly clear, although several fairly natural assemblages are evident. One of these centers around *Oryzomys*, another around *Akodon*, a third around *Sigmodon*, still another around *Phyllotis*, and possibly another has been derived from *Peromyscus*. A few highly specialized, isolated, or little known forms do not fall readily into any of these divisions. Among these are *Irenomys*, *Punomys*, *Scapteromys*, *Rhagomys*, *Ichthyomys* and allies. At present their position must be regarded as uncertain. For want of a better place *Irenomys* might be included among the allies of *Phyllotis* but the connection is not fully evident.

The *Phyllotis* group is now so well represented in the Chicago Museum (over 800 specimens) that it seems practical to attempt an evaluation of the generic and subgeneric divisions that have been proposed and some review of the principal species included. The group apparently is one of fairly long standing in South America, since it shows no close affinity to living northern forms, since it includes some forms of marked distinction, and since its distribution is relatively limited. In number of distinct types and also in abundance of individuals the group is concentrated in the high Andean region of southern Peru and Bolivia. From there one or two species range to southern Ecuador, one or two extend south to Patagonia, and several others are found in eastern Brazil, north central Argentina, and Uruguay. In considering the group as a whole it appears that there are only two widely distributed assemblages consisting of species which are relatively uniform in character. These are typical *Phyllotis* and *Hesperomys*. Aside from them are several types quite sharply distinguished but represented only by one or very few species of limited distribution. Some of these, as *Andinomys* and *Chinchillula*, seem to be survivals from an earlier period and stand well apart. Others, also monotypic or practically so, are evidently more recently derived and their characters, although plain enough, are incipiently shown individually or in combinations by certain members of the more widespread and generalized groups. A subgeneric position for most of these seems to be the only means by which their relative affinities and probable evolutionary history can be indicated by classification and nomenclature.

The following arrangement is now proposed with a separate discussion of each component.

Genus **Hesperomys**
H. bimaculatus et al.
Genus **Eligmodontia**
E. typus et al.
Genus **Phyllotis**
Subgenus **Phyllotis**
P. darwini et al.
Subgenus **Graomys**
P. griseoflavus et al.
Subgenus **Paralomys**
P. gerbillus
Subgenus **Galenomys**
P. garleppi
Subgenus **Auliscomys**
P. pictus, *P. sublimis*, *P. boliviensis*
Subgenus **Loxodontomys**
P. micropus
Genus **Andinomys**
A. edax
Genus **Chinchillula**
C. sahamae

Genus **Hesperomys** Waterhouse

Type *Mus bimaculatus* Waterhouse, from Maldonado, Uruguay.

The essential character of *Hesperomys* which uniformly distinguishes it from *Phyllotis* and all other members of the group is found in its low-crowned teeth. Except in late stages of wear these are almost tuberculate rather than flat-surfaced and prismatic. It may be concluded, therefore, that this is the most primitive of the living forms. The name *Hesperomys* has been applied to certain South American Pliocene fossils but their generic identity with modern forms is more than doubtful.

The genus includes a number of species ranging from southeastern Brazil and Uruguay to northern Argentina, through southern Paraguay to Bolivia and, in diminished numbers, via Peru to southern Ecuador (one species only). All are rather small, some quite tiny, and although most are short-tailed a few have fairly long tails. In some of the larger forms the skull shows widened frontals with the supraorbital edges sharp or slightly ridged, a condition which Thomas and Ellerman have compared to that seen in *Graomys*. That this indicates any close affinity rather than parallelism seems extremely doubtful. In these larger species the skull differs markedly from that of *Graomys* in its short rostrum and nasals, its narrow braincase, and its small audital bullae. Although the supraorbital ridges are scarcely evident in the smaller species the frontals are usually wide and the edges divergent.

In a considerable proportion of the species there is a great increase in the number of mammae to a total as high as 14, although in some others the formula is 2-2=8 as in all other members of the *Phyllotis* group. If other characters should be correlated with the multimammate condition, therefore, it is possible that the genus might be subdivided, but more study than has yet been practical should precede any such action.

Important species of *Hesperomys* are *expulsus*, *tener*, *bimaculatus*, *laucha*, *muriculus*, *venustus*, *lepida*, *sorella* and *frida*.

Genus **Eligmodontia** F. Cuvier

Type *Eligmodontia typus* F. Cuvier from the vicinity of Buenos Aires, Argentina.

Recognition of *Eligmodontia* as a full genus appears to be demanded by the specialization of its feet, especially the hind feet. This was noted by Thomas as early as 1916, but that it was more than mere hairiness, a somewhat variable condition in many small rodents, seems not to have been generally appreciated. The hind feet are in fact relatively long, slender proximally, and expanded distally with the soles not only set with short hairs but with a prominent, rounded and hairy "cushion" developed on the ball of the foot. Although still far from it, this is suggestive of the densely hairy condition of the feet of the saltatorial American kangaroo rats and the Old World gerbils. The usual naked pads are much reduced, the posterior carpal one absent and the subdigital ones small and aborted.

The skull offers no especial peculiarities but seems more like that of *Phyllotis* than that of *Hesperomys*. The teeth are obviously more hypsodont than those of *Hesperomys* but possibly a little less so than in *Phyllotis*.

The species of *Eligmodontia* are relatively few. The better known forms are closely related and include *typus*, *elegans*, *hirtipes* and *puerulus* ranging from southern Bolivia and northern Chile thence east of the Andes to southern Argentina, extending on the east coast as far north as the vicinity of Buenos Aires. They have the general appearance of small *Phyllotis* with slender bodies, long tails, and silky pelage. The ears are larger than in *Hesperomys* but smaller than in typical *Phyllotis*. Possibly no more than two distinct species are concerned. A very distinct additional species is *marica* which is quite small, short-tailed, small-eared, and distinctively colored.

Genus **Phyllotis** Waterhouse

Type *Mus darwini* Waterhouse from Coquimbo, Chile.

As a genus, *Phyllotis* includes first some five or six wholly distinct species all of which are so closely similar to typical *darwini* that no one has ever suggested they be subdivided. A number of others are obviously related to this typical group but differ from it and from each other so markedly that many of them have received special names, opinions differing as to whether they should be treated as genera or subgenera. Pure classification, regardless of nomenclature, seems to require some overall recognition of their common relationship to the typical forms and their probable derivation from less specialized ancestors now represented by these typical forms. This can be accomplished to a considerable extent by one inclusive genus and various subgenera. Discussion follows under the subgeneric headings.

Subgenus *Phyllotis* Waterhouse

In the typical species *darwini*, the body is slender, the tail as long as the head and body or longer, the ears large and leafy, the pelage silky, and the feet naked or slightly hairy proximally with the plantar pads normal. The skull is regular in outline, the zygomata nearly parallel and the interorbital space narrowed; the frontals are parallel-sided anteriorly and but little or only moderately expanded posteriorly; the supraorbital edges are rounded or slightly elevated; the infraorbital plate is wide with its front edge vertical or concave and angled at the top, even hooked, rather than rounded. The cheekteeth have their outer lobes nearly opposite the inner ones and at right angles to the axis of the skull; the parastyle of the second upper tooth is rudimentary or only slightly developed, disappearing in early stages of wear; the upper incisors are orthodont.

The above characters are subject to little or almost no variation in the numerous subspecies of the wide-ranging *darwini* and they are also essentially repeated in several other species apparently quite distinct from *darwini*. These last are *lutescens* (*andium*), *haggardi*, *amicus*, *nogalaris*, *definitus*, *fuscus*, and *phaeus*. With *darwini*, therefore they form a compact natural group, probably the central

and most generalized one. That the various aberrant species of other subgenera were immediately derived from this group can hardly be assumed but it is fair to suppose that this group most nearly represents the ancestral type from which all have come, the direct antecedents of the specialized forms now being extinct.

Subgenus *Graomys* Thomas

Type *Mus* (*Phyllotis*) *griseoflavus* Waterhouse from Rio Negro, Argentina.

The several species to which the name *Graomys* applies are in most cases readily recognized by a single cranial character, the widened, divergent, and sharp-edged frontal bones. This has led to a tendency to give the group full generic rank, although in every other respect very close affinity to *Phyllotis* is indicated. Externally there is practically complete agreement with *P. darwini* and the dentition differs only in some enlargement of the parastyle of the second upper cheek-tooth, a character which is repeated in varying degrees throughout the group. The infraorbital plate is more deeply concave than in typical *Phyllotis* but in this there is more resemblance to *Phyllotis* than to any other subgenus.

The better known forms of *Graomys* are rather large in size which tends to magnify the importance of the widened frontals. In the small species *amicus* and *haggardi*, never regarded as anything but *Phyllotis*, the frontals are considerably widened and divergent, although not definitely sharp-edged. In this respect at least, they seem to stand midway between *P. darwini* and *Graomys*, or even nearer to *Graomys*. Measurements of the frontals of *Graomys domorum*, *P. amicus*, and *P. darwini* give results in which the ratio of the interorbital width to the total length of the skull is 16.6 in *domorum*, 17.2 in *amicus*, and 14.3 in *darwini*. For the greatest width of the frontals behind, the ratios are respectively 30, 31.5, and 26. On this basis, therefore, *amicus* is nearer to *Graomys* than to *Phyllotis* Figures, however, are not always trustworthy and what seems evident here is that in *amicus* we have one of those too frequent species leading from one supposed generic group into another.

A further small species, not available in the present connection, but which has been referred to *Graomys* Cabrera (Notas Prel. Mus. La Plata, Univ. Nac., Buenos Aires, vol. 3, p. 124, 1934), is described as having dimensions almost exactly as in *amicus*. Also agreeing in both external and cranial measurements is *Phyllotis oreigenus* (Cabrera, Rev. Chilena Hist. Nat., vol. 30, p. 319, 1926).

It seems, therefore, that *Graomys* is a relatively recent offshoot of *Phyllotis* with connecting species still existing. Its departure from the generalized types is less than in any of the other subgenera here recognized and consistency requires that it be ranked as a subgenus rather than a genus.

Of ten named larger forms usually assigned to *Graomys* it is doubtful if more than three fully specific types are represented, perhaps only two. One series having large audital bullae and mainly pure white underparts (in adults) includes *griseoflavus*, *cachinus*, *chacoensis*, and *medius*. Another having smaller bullae and underparts largely with dark-based hairs includes *domorum*, *taterona*, and *lockwoodi*. Definitely smaller forms not examined are *edithae* and *hypogaeus*.

Subgenus *Paralomys* Thomas

Type *Phyllotis gerbillus* Thomas from desert of Piura, Peru.

Owing to its very distinctive external appearance, the species *gerbillus* stands out among its relatives, but no very unusual generic or subgeneric characters for it have been pointed out.

In a single specimen from the original series compared with *Phyllotis amicus* of approximately the same size and age no tangible dental peculiarities appear and it is difficult to find anything in the skull which might serve as more than a specific character. In *gerbillus*, the braincase is a little narrower than in *amicus*. Otherwise there is essential agreement in detail. The original reference to *Phyllotis* by Thomas, therefore, seems more justifiable than that to *Hesperomys* suggested by Ellerman (1941). The teeth are certainly more hypsodont than in *Hesperomys* and in the one specimen at hand differ but slightly from those of typical *Phyllotis*. Series of specimens, including young with unworn teeth, might furnish some distinctions, but in the absence of these, little appears beyond the external characters. The ears are small and leathery, the pelage short and close, the tail long and closely haired, the color bright ochraceous above and pure white below. The soles of the hind feet, while having normal pads, differ from those of *Phyllotis* in being sparsely covered with fine short hairs.

The one species concerned is known only from a small series taken at one locality as long ago as 1899 since which time it has not been recorded. Further information as to its range and variation is much to be desired.

Subgenus *Galenomys* Thomas

Type *Phyllotis garleppi* Thomas from Mount Sahama, Bolivia.

The single species *garleppi* is widely different from typical *Phyllotis*, being distinguished by its extremely short tail and densely hairy feet as well as by various cranial characters. The zygomata are widened, especially anteriorly, the interorbital region is elevated giving the dorsal outline of the skull an arched appearance, the front of the infraorbital plate is rounded above and decidedly sloping downward and forward; the upper incisors are proodont and the parastyle of the second upper cheektooth is somewhat more functional than in typical *Phyllotis*.

On the basis of these characters there could be little objection to giving *Galenomys* independent generic rank were it not for the existence of three species, now referred to the subgenus *Auliscomys*, which show definite approach to it and seem to stand between it and typical *Phyllotis*. All of these have relatively short tails, although none so extreme as in *garleppi*, while cranial and dental characters are mostly repeated in varying degrees, leaving the hairy feet and the arched interorbital region as the only distinctions of *garleppi* which are not of a relative nature. It seems likely that this indicates a common derivation for *Galenomys* and *Auliscomys*, but *Galenomys* has now departed so far from the others that its subgeneric separation is well justified.

Apparently the quite remarkable form *Galenomys* is so far known only from two specimens, the type, which is said to have a damaged skull, and a perfect specimen from the type region now in the Chicago Museum.

Subgenus *Auliscomys* Osgood

Type *Reithrodon pictus* Thomas from Junin, Peru.

Three rather diverse species, *pictus*, *sublimis*, and *boliviensis*, may be associated under the subgeneric name *Auliscomys*. Collectively they seem to stand between typical *Phyllotis* and *Galenomys*, but they differ so among themselves that characterization is difficult. Each has unique features and each has resemblances both to *Galenomys* and to *Phyllotis*. Thus they illustrate the not uncommon situation among South American cricetids in which there is a high degree of differentiation [i.e. *Phyllotis* (s.s.) versus *Galenomys*] combined with the continued existence of species suggesting the course this differentiation has followed. In this case there is no direct gradation but the three species of *Auliscomys*, each in its particular way, carry the inference that there was a gradation in which each was concerned and of which it is now a survival.

Specifically it is found that the proodont incisors of *Galenomys* are fully equalled in *boliviensis*, slightly evident in *sublimis*, and not at all in *pictus*. The form of the infraorbital plate is nearly the same in *boliviensis* as in *Galenomys*, less like it in *sublimis*, and still less so in *pictus*, although not quite as in typical *Phyllotis*. The widened anterior zygomata of *Galenomys* are shown by *sublimis* but scarcely by *bolivinsis*, and not at all by *pictus*. All agree in the character of the parastyle of the second upper cheektooth. The grooved incisors of *pictus* are shared by *sublimis*, at least in about seventy percent of specimens examined, but in *boliviensis* the incisors are never grooved. Small ears also are common to *pictus* and *sublimis* while in *boliviensis* the ears are large. In *boliviensis* the audital bullae are large as usual in correspondence with large external ears and in *sublimis* the bullae are small corresponding to small ears. In *pictus*, however, although the external ears are even smaller than in *sublimis*, the audital bullae are quite as large as in many of the large-eared forms. This may be taken as further evidence that the three species concerned are survivals of a period of active speciation of which the details are now missing and in which each was left with a mixture of characters removing it from typical *Phyllotis* and *Galenomys* but not importantly distinguishing any one of the three from either of the others.

Some thirty years ago the name *Auliscomys*, with *pictus* as type, was proposed under the mistaken belief, concurred in by Thomas, that the grooved incisors indicated relationship to *Euneomys*. At that time no actual specimens of *Euneomys* were in hand, but comparisons now possible show conclusively that *Euneomys* is wholly distinct and probably not even a member of the *Phyllotis* group.

Subgenus *Loxodontomys* novum

Type *Mus micropus* Waterhouse from Santa Cruz River, Patagonia.

The abundant, wide-ranging species *micropus* has always been regarded as an anomalous member of the *Phyllotis* group and efforts to associate it with any other species have been very unsatisfactory. It differs from every other member of the group in external, in cranial, and in dental characters. Therefore, a separate

subgeneric name for it seems justified, thus recognizing nomenclaturally the independent position it has always occupied in the minds of those familiar with it.

Externally it is stout-bodied and short-tailed, with small rounded ears and loose lusterless pelage. These features combined with the nearly uniform color of upper and under parts give it an almost microtine appearance greatly in contrast to the usual condition in the group in which, especially in typical *Phyllotis* and *Graomys*, the body is slender, the tail long, the ears large, the pelage silky and appressed, and the color of upper and under parts sharply separated. Efforts to associate it with short-tailed forms of *Auliscomys* were admittedly provisional (*cf.* Mamms. Chile, pp. 211–214, 1943) and the tendencies of these toward *Galenomys* now evident seem to indicate that it has no very close relationship to them.

Cranially it differs considerably from typical *Phyllotis* and *Graomys*, but as in *Auliscomys*, the skull offers a combination of characters. The interorbital region is narrow and slightly concave between the moderately elevated edges, and the braincase is wide and full; the zygomata are markedly compressed anteriorly and widened posteriorly giving the outline of the skull a somewhat triangular effect quite the opposite of that seen in *Galenomys*. The front of the infraorbital plate is nearly vertical and slightly rounded at the upper angle; the toothrows are somewhat convergent anteriorly whereas in other forms they are parallel or definitely divergent in front instead of behind.

The dentition is unique, especially in the forward inflection of the outer elements of the cheekteeth. The parastyle of the second upper tooth is very strong, much more evident than in *Phyllotis*, considerably more than in *Auliscomys*, and slightly more than in *Graomys*.

Genus **Andinomys** Thomas

Type *Andinomys edax* Thomas from Potosi, Bolivia.

This genus is sharply set off from *Phyllotis* and all other members of the group except *Chinchillula* by its highly hypsodont and prismatic cheekteeth. These are flat-crowned from earliest stages and as wear proceeds there is pronounced tendency to the formation of closed triangles. The pattern differs in detail from that of the low-crowned forms, but the principal elements, although sharp-angled, are much the same including a well marked parastyle in the second upper tooth. There is considerable resemblance to the extinct genera *Ptyssophorus*, *Tretomys*, *Necromys*, and *Bothriomys* from the Pleistocene of eastern Argentina which have been thought to have some relationship to the woodrats (*Neotoma*) of North and Central America although these are otherwise unrepresented in South America.

Externally *Andinomys* has considerable similarity to *Phyllotis*, but is very heavy-bodied, rather short-tailed and small-eared. Its skull is heavy and has numerous minor characters. The front of the infraorbital plate is concave as in *Phyllotis*, the nasals are widened anteriorly, and the interorbital region is constricted. In ten skulls examined there is a slitlike opening between the frontals at the center of the interorbital region.

One species, *edax*, is known with a single subspecies, *lineicaudatus*.

Genus **Chinchillula** Thomas

Type *Chinchillula sahamae* Thomas from Esperanza, Mount Sahama, Bolivia.

This extraordinary monotypic genus may safely be regarded as the most specialized member of the entire group. As in *Andinomys* the cheekteeth are highly hypsodont, flat-crowned and prismatic. Their pattern is somewhat simpler, however, and the parastyle of the second upper tooth is completely suppressed. The principal elements of the teeth are more nearly opposite each other than in *Andinomys* and not so sharp-angled.

The skull offers no especial peculiarities, being regular in form and generally similar to that of the smaller *P. boliviensis*. The interorbital region is not greatly constricted and the front edge of the infraorbital plate is straight but sloping downward and forward. The maxillopremaxillary suture is nearly vertical but somewhat farther forward than in other forms, reaching to the front edge of the infraorbital cavity.

The bodily proportions are much as in *Andinomys*, but the very long full pelage and the remarkable particolored markings are unique. The one species lives at very high altitudes and is restricted to a small area in southern Peru and western Bolivia.

It may well be that *Chinchillula* and *Andinomys* are descended directly from extinct forms already differentiated along similar lines in the Pleistocene, but their affinity to living members of the *Phyllotis* group is scarcely to be doubted.

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GEOGRAPHIC VARIATION IN PEROGNATHUS HISPIDUS

By Bryan P. Glass

Since the original description of the species *Perognathus hispidus* by Baird in 1857, seven different names have been proposed for populations from the several parts of its range. Some of these are now considered synonyms, while the others are recognized as only subspecifically distinct from the form described by Baird. In addition one form was for a time mis-identified as *Perognathus fasciatus*.

In revising the genus Osgood (N. Amer. Fauna, 18, 1900) placed *P. paradoxus* as a subspecies of *P. hispidus*. As reason for this he stated that except for size, with a consequently heavier and larger skull, and softer pelage, there were no essential differences between the two. He added that with the consideration of *P. conditi* and *P. paradoxus spilotus* there was an even and gradual gradient from one form to the other. On this basis, he included *P. p. spilotus* of Merriam and the *P. paradoxus* series of Allen under the subspecies *P. hispidus hispidus*, and reduced the two species, *P. latirostris* and *P. conditi* to synonyms of the subspecies *P. hispidus paradoxus*. In addition Osgood described a new subspecies, *Perognathus hispidus zacatecae*, on the basis of specimens from the central Mexican plateau.

A further addition to the nomenclature of the *hispidus* group was made by Elliot (Field Columb. Mus. publ. 87, zool. ser., vol. 3, 1903) when he described

Perognathus hispidus maximus to include the large dark form found in the Indian Territory of what is now the state of Oklahoma. His type series was taken near Noble, and was described as being brighter in color than *paradoxus*, with more black mixed with the ochraceous hairs of the back.

Blair (Amer. Midl. Nat., vol. 22, 1939) recognized that the subspecies *P. h. maximus* proposed by Elliot was identical with the subspecies *P. paradoxus spilotus* proposed by Merriam in 1889. He stated further that "although it is unfortunate that the type locality and series selected by Merriam is near the limit of range, and shows intergrading characters with other forms, this does not invalidate the name *spilotus*, since the forms are recognizably different." He therefore reestablished the name *spilotus* and discarded *maximus* as a synonym.

It was the intent of the present study to bring together the knowledge of geographic variation in this species and to determine the characters that have taxonomic significance. The species is widely distributed, and there is marked individual variation, even from the same parts of the range. Many of the characters formerly used to diagnose the different subspecies have been found to vary so widely that they cannot have any taxonomic importance while others may be used only with reservation.

The study was based on 377 specimens from practically the entire known range of the species, and included topotypes of all forms except *P. hispidus hispidus*.

The characters used herein have been largely the classical ones—total length, length of head and body, length of tail, length of hind foot, and pelage color. Occipitonasal length, mastoid breadth, dimensions of the interparietal bone, width of the interorbital region, nasal length, and relative length of the maxillary bone are the cranial dimensions that have been used. Body measurements have been taken from the specimen tags, but the cranial measurements have been made by the author, using vernier calipers recording to the nearest 0.1 mm.

In deriving averages, several of the longer series were selected and separate averages for males and females were made to ascertain the amount and nature of sexual differences. Comparisons of total length, length of tail, length of body, interparietal breadth, and interorbital width showed that in some series males averaged larger than females, while in others the females averaged larger. This lack of constant sexual difference was noticed in all measurements, and it is interpreted as indicating that one average including both sexes is more typical of the form as a whole than the average of one sex. Consequently, in the discussions to follow averages include both sexes.

The distributional study has been based on the specimens mentioned above, together with a number of locality records that have been found in the literature, or obtained from collectors, without the actual specimens being at hand. These records have been accepted for use in plotting the range of the species, but only for that purpose. In no case have subspecific identifications been accepted where the specimens themselves were not available for study and comparison.

From study of the characters listed above it has been concluded that three subspecies of *Perognathus hispidus* occurr in the United States. The range of the Mexican race, *P. h. zacatecae*, is at present imperfectly known. In the collec-

tions upon which the current discussion is based only seven mature specimens from two widely separated locations have been available. These have sufficed to show that the form is separable from the other subspecies, but they have been insufficient to demonstrate the extent of its range. Locations from which *zacatecae* have been taken are Valparaiso, Zacatecas, the type locality, Celaya, Guanajuato, and 85 kilometers north of Mexico City on the Pan-American

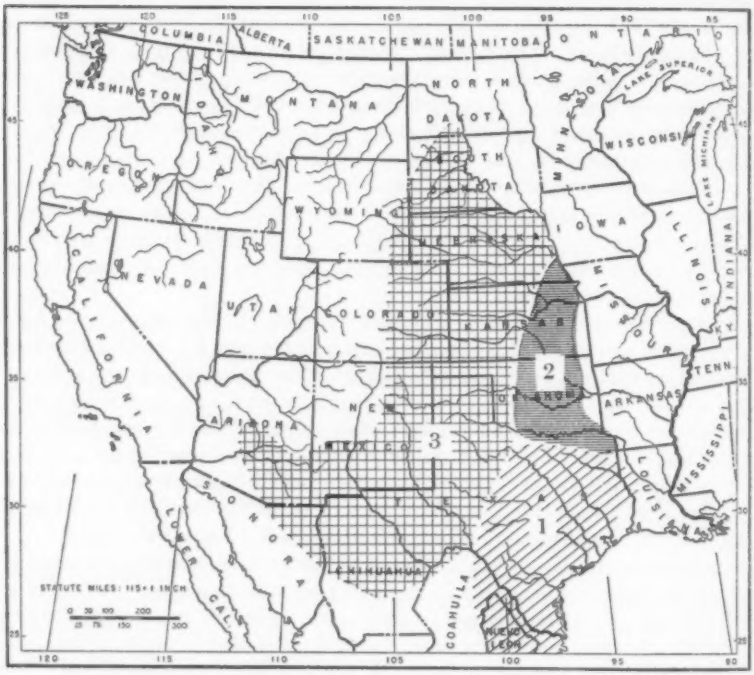

FIG. 1.—Map showing distribution of *Perognathus hispidus*. 1. *P. h. hispidus*, 2. *P. h. spilotus*, 3. *P. h. paradoxus*.

highway in Hidalgo. These locality records indicate that this form occupies the higher plateau of central Mexico.

To give the problem maximum scope, it was necessary to borrow material from as many collections as possible. Acknowledgments are due to the persons in charge of mammal collections of the United States Fish and Wildlife Service (USFWS), the American Museum of Natural History (AMNH), the Chicago Natural History Museum (CNHM), the University of Kansas Museum of Natural History (KUMZ), the University of Michigan Museum of Zoology (UMMZ), the University of Oklahoma Museum of Zoology (UOMZ), the Louisiana State University Museum of Zoology (LSUMZ), and the Colorado Museum of Natural History (CMNH) for their gracious loan of specimens for study.

Acknowledgment is also made of the assistance given by Dr. William B. Davis, under whose supervision the project was initiated and completed.

Perognathus hispidus hispidus Baird

Perognathus hispidus Baird, Mammals N. Amer., p. 421, 1857. Type from Charco Escondido, Tamaulipas, Mexico.

Diagnosis.—Total length averaging less than 200 mm.; length of hind foot averaging approximately 23 mm.; occipitonasal length averaging less than 30 mm.; mastoid breadth averaging less than 15 mm.; interparietal narrower than interorbital width; premaxillae extend posteriorly beyond nasals; color of upperparts ochraceous; forearm usually white.

Distribution.—*P. h. hispidus* occupies the greater part of Texas, except for the high plains, the Trans-Pecos area, and the Red River Valley, which are occupied by other subspecies. It occurs sparingly in the forested region of eastern Texas and western Louisiana. It becomes more abundant in central and southern Texas and is found in northern Mexico as far west as Sabinas, Coahuila, and as far south as Ciudad Victoria, Tamaulipas. Lack of specimens prevents accurate outlining of the area of intergradation with *P. h. paradoxus*.

Remarks.—Four specimens taken from Vowell's Mill and Hutton, localities in Natchitoches and Vernon parishes, Louisiana, present a problem. They are small, falling well within the size limits of typical *hispidus*, and the skull dimensions also are those of *hispidus*. They have mature pelage, and in two of them the cranial sutures demonstrate maturity, but in two others the sutures indicate immaturity. All four of them manifest affinity with the *paradoxus-spilotus* group in the relationship of the interparietal to the interorbital breadth. Larger series of fully mature animals will be needed to determine their true identity, but until then they are best referred to *hispidus*.

Specimens examined.—Total number 106, as follows. **Texas:** *Aransas Co.:* Aransas Refuge, 3 (TCWC); Old Refuge Hqs., 1 (TCWC); Dagger Point, 2 (TCWC); Rockport, 2 (USFWS), 6 (CMNH). *Bee Co.:* Beeville, 1 (USFWS). *Bexar Co.:* San Antonio, 3 (USFWS), 1 (CNHM). *Brazos Co.:* Pasture 9, Texas A. & M. College Farm, 2 (TCWC); 10 mi. E College Station, 1 (TCWC); 1 mi. NE Millican, 1 (TCWC). *Brooks Co.:* 3 mi. S Falfurrias, 2 (TCWC). *Cameron Co.:* Brownsville, 1 (CMNH), 1 (KUMZ), 5 (USFWS), 9 (AMNH); Lomita Ranch, 1 (USFWS); Santa Rosa, 1 (USFWS); Sauz Ranch, 1 (USFWS). *Colorado Co.:* 9 mi. E Eagle Lake, 1 (TCWC). *De Witt Co.:* Cuero, 1 (USFWS). *Eastland Co.:* 5 mi. NE Cisco, 1 (KUMZ). *Goliad Co.:* 8 mi. SW Goliad, 1 (TCWC). *Guadalupe Co.:* Seguin, 1 (USFWS). *Harris Co.:* 2.5 mi. N Hockley, 1 (TCWC). *Kerr Co.:* 20 mi. W Mountain Home, 6 (TCWC), Near Kerrville State Park, 3 (TCWC); 4 mi. NE Center Point, 3 (TCWC); Kerrville, 1 (TCWC). *Kleberg Co.:* 1 (UMMZ); 2 mi. S Riviera, 1 (TCWC). *La Salle Co.:* 8 mi. NE Los Angeles, 7 (TCWC); 2 mi. S Woodward, 2 (TCWC); 35 mi. SE Cotulla, 1 (TCWC). *Lavaca Co.:* near Sweet Home, 1 (TCWC). *Llano Co.:* Llano, 1 (USFWS). *Nueces Co.:* Corpus Christi, 1 (USFWS); Nueces Bay, 1 (USFWS). *Palo Pinto Co.:* Brazos, 1 (USFWS). *San Patricio Co.:* Chilcipin Creek, 1 (USFWS). *Smith Co.:* Tyler, 1 (TCWC). *Starr Co.:* Roma, 1 (USFWS). *Trinity Co.:* 9 mi. W Trinity, 1 (TCWC). *Val Verde Co.:* Del Rio, 1 (USFWS); Mouth of Sycamore Creek, 1 (USFWS). *Walker Co.:* 1 mi. SW Huntsville, 2 (TCWC); 1.5 mi. E Huntsville, 1 (TCWC). *Webb Co.:* Santa Tomas, 1 (USFWS). *Willacy Co.:* Redfish Bay 28 mi. E Raymondville, 4 (TCWC). **Louisiana:** *Natchitoches Par.:* Vowell's Mill, 2 (LSUMZ). *Vernon Par.:* Hutton, 2 (LSUMZ). **Mexico:** *Coahuila:* Sabinas, 1 (USFWS). *Tamaulipas:* Linares, 1 (USFWS); Mier, 1 (USFWS); Mulato, 3 (UMMZ); Nuevo Laredo, 1 (USFWS); Victoria, 1 (USFWS).

Perognathus hispidus spilotus (Merriam)

Perognathus paradoxus spilotus Merriam, N. Amer. Fauna, no. 1, p. 25, 1889. Type from Gainesville, Cooke County, Texas.

Perognathus hispidus maximus Elliot, Field Columb. Mus., publ. 87, zool. ser. vol. 3, p. 253, 1903. Type from Noble, Cleveland County, Oklahoma.

Diagnosis.—Total length averaging 200 mm. or more; length of hind foot averaging 25 mm.; occipitonasal length averaging more than 30 mm.; interparietal wider than interorbital breadth; premaxillae and nasals ending on same plane posteriorly; upperparts bright, dark ochraceous; color of lateral line encroaching on forearm.

Distribution.—*P. h. spilotus* occupies the eastern parts of Oklahoma, Kansas, and the Red River Valley of Texas. Its range is bounded on the east by the Missouri River and the Ozark Mountains, while to the south, it intergrades with *P. h. hispidus* and to the west with *P. h. paradoxus*. In the west the zone of intergradation extends northwards not far from the western border of Oklahoma, passing through the eastern edge of Dewey County, then through the middle of Woods County where *spilotus* is found in the eastern and *paradoxus* in the western part. From this county the line of division extends northeastward passing between Barber and Harper counties in southern Kansas. North of this area the line becomes less well defined, owing to a dearth of specimens from eastern Kansas. A series from Cloud County, however, seems to be almost exactly intermediate between the two forms, while specimens from Marion and Greenwood counties to the southeast are clearly *spilotus*. From Cloud County north the zone is not yet exactly defined. It is evident that it proceeds northeastwards, toward the Missouri River since 2 specimens from eastern Nebraska, a juvenile from Webster County and an adult from Lancaster County, are both typical *paradoxus*. The southern boundary of the range of *spilotus* crosses the Red River somewhere between Chillicothe, Hardeman County, and Henrietta, Clay County, Texas. *P. paradoxus* is found at the former location, and *spilotus*, tending towards *paradoxus*, at the latter; *spilotus* occurs also in Texas at Gainesville in Cooke County, and Jefferson in Marion County, while further south Brazos in Palo Pinto County, and Tyler in Smith County yield the smaller *P. h. hispidus*.

Specimens examined: Total number 103, as follows. **Kansas:** *Cloud Co.:* 1 (UMMZ); 3 mi. E Concordia, 4 (KUMZ). *Cowley Co.:* Arkansas City, 2 (KUMZ). *Greenwood Co.:* 4 mi. S 14 mi. W Hamilton, 1 (KUMZ); 8 mi. SW Toronto, 4 (KUMZ); 6 mi. N Aetna, 1 (KUMZ). *Harper Co.:* 1 (KUMZ); 5 mi. NW Harper, 5 (KUMZ). *Marion Co.:* 0.5 mi. E Lincolnville, 1 (KUMZ). **Oklahoma:** *Blaine Co.:* Canton, 1 (KUMZ). *Cleveland Co.:* Noble, 4 (CNHM); 5 mi. S Norman, 1 (UOMZ); 2 mi. N Norman, 2 (UOMZ); 2.5 mi. NE Norman, 2 (UOMZ); 3 mi. E Norman, 8 (UOMZ). *Comanche Co.:* Chattanooga, 2 (USFWS); Lawton, 1 (USFWS). *Dewey Co.:* 5 mi. W Canton, 8 (KUMZ); 5.5 mi. SW Canton, 2 (KUMZ). *McLain Co.:* 2 (UOMZ). *Muskogee Co.:* 3 mi. E Wainwright, 4 (UOMZ). *Payne Co.:* Stillwater, 1 (UMMZ). *Rogers Co.:* Garnett, 22 (UMMZ). *Tulsa Co.:* 8 mi. W Red Fork, 1 (USFWS); Garnett, 8 (UMMZ). *Noble Co.:* Arnettville, 2 (CNHM). *Woods Co.:* Alva, 6 (CNHM); White Horse Springs, 2 (CNHM). *Logan Co.:* Orlando, 1 (USFWS). **Texas:** *Cooke Co.:* Gainesville, 3 (USFWS).

Perognathus hispidus paradoxus (Merriam)

Perognathus paradoxus Merriam, N. Amer. Fauna, no. 1, p. 24, 1889. Type from Banner, Trego County, Kansas.

Perognathus latirostris Rhoads, Amer. Nat., vol. 28, p. 185, 1894. Type from "Rocky Mountains."

Perognathus conditi Allen, Bull. Amer. Mus. Nat. Hist., vol. 6, p. 318, 1894. Type from San Bernadino Ranch, Cochise County, Arizona.

Diagnosis.—Total length averaging more than 200 mm.; hind foot averaging about 25 mm.; occipitonasal length averaging more than 30 mm.; mastoid breadth averaging more than 15 mm.; interparietal wider than interorbital width; upperparts ashy ochraceous; color of forearm variable, white or ochraceous.

Distribution.—The range of *P. h. paradoxus* extends across the short and mixed grasslands and the southwestern desert, and includes a small part of North Dakota, almost all of South Dakota west of the Missouri River, the extreme eastern edge of Wyoming, almost all of Nebraska (except the part occupied by *spilotus*), the eastern half of Colorado, western Kansas (west of the line previously outlined), the panhandle and extreme western portion

of Oklahoma, the high plains and Trans-Pecos areas of Texas, the eastern and southern parts of New Mexico, except for the higher mountains, the central and southeastern parts of Arizona, and the plateau of Sonora in Mexico. Its southern limits are not known, and its points of contact with *hispidus* to the east and with *zacatecae* to the south are yet to be outlined.

Specimens examined: Total number 154, as follows. **Arizona:** *Cochise Co.:* 2 mi. E Portal, 1 (UMMZ); 3 mi. N Portal, 1 (UMMZ); 12 mi. SE Dos Cabezos, 1 (UMMZ); Mouth of Miller Canyon, Huachuca Mts., 2 (UMMZ); Chiricahua Mts., mouth of Turkey Creek, 2 (USFWS); Bonita, 1 (USFWS). *Pima Co.:* 12 mi. NW Tucson, 1 (AMNH). **Colorado:** *Adams Co.:* 25 mi. S Fort Morgan, 1 (UMMZ). *Baca Co.:* Furnace Canyon, 1 (CMNH). *Douglas Co.:* Parker, 1 (CMNH); 3 mi. SE Parker, 1 (CMNH); Daniels Park, 1 (CMNH). *Otero Co.:* Wray, 5 (CMNH). *Washington Co.:* Akron, 1 (UMMZ). *Weld Co.:* Horsetail Creek, 1 (CMNH). **Kansas:** *Ellis Co.:* Ellis, 1 (USFWS). *Ellsworth Co.:* 1.5 mi. S Wilson, 1 (KUMZ). *Hamilton Co.:* 1 mi. E Coolidge, 2 (KUMZ). *Kiowa Co.:* 5 mi. N Belvidere, 1 (KUMZ); 15 mi. N Belvidere, 5 (AMNH). *Lane Co.:* Pendennis, 1 (AMNH); 12 mi. S Pendennis, 1 (KUMZ). *Logan Co.:* 5 mi. W Elkader, 2 (KUMZ). *Meade Co.:* 17 mi. SW Meade, 3 (KUMZ); 14 mi. SW Meade, 3 (KUMZ); 13 mi. SW Meade, 6 (AMNH). *Morton Co.:* 2 (KUMZ). *Phillips Co.:* 2 mi. S and 1 mi. E Long Island, 2 (KUMZ). *Rawlins Co.:* 1 mi. N McDonald, 1 (KUMZ); 4 mi. N Atwood, 1 (KUMZ); 2 mi. NE Ludell, 1 (KUMZ). *Seward Co.:* 1 mi. E Arkalon, 1 (KUMZ). *Trego Co.:* Banner, 8 (KUMZ); 8 mi. N Wakeeney, 1 (KUMZ); Purinton Ranch, 1 (KUMZ). *Hays Co.:* 2 (USFWS). **Nebraska:** *Box Butte Co.:* 1 (UMMZ). *Cherry Co.:* 1 (USFWS); Valentine, 10 (UMMZ); 12 mi. SE Gordon, 1 (CNHM). *Custer Co.:* 0.5 mi. E Victoria Springs, 4 (UMMZ). *Hooker Co.:* Kelso, 6 (UMMZ). *Lancaster Co.:* 9 mi. N Lincoln, 1 (UMMZ). *Lincoln Co.:* 6 mi. NE Dickens, 1 (UMMZ); Myrtle P. O., 1 (USFWS). *Logan Co.:* Sterling, 1 (USFWS). *Webster Co.:* Red Cloud, 1 (USFWS). **New Mexico:** *Socorro Co.:* Dry Creek, 1 (USFWS). *Catron Co.:* Red Rock, 1 (USFWS). *Colfax Co.:* 3 mi. SE Cimarron, 3 (AMNH). *Hidalgo Co.:* Cloverdale, Philmont Ranch, 1 (AMNH). *Otero Co.:* Tularosa, 1 (USFWS). Cuervo, N. M., 1 (USFWS). **Oklahoma:** *Texas Co.:* 2 mi. E Eva, 1 (KUMZ). *Woods Co.:* 2 mi. W Edith, 1 (USFWS). **South Dakota:** *Custer Co.:* Elk Mountain, 2 (USFWS). *Fall River Co.:* 11 mi. SE Hot Springs, 1 (UMMZ). *Shannon Co.:* Pine Ridge, 1 (CNHM). *Tripp Co.:* 1 mi. SE Colome, 1 (UMMZ). *Washabaugh Co.:* Cottonwood Canyon Kadoka, 1 (UMMZ); Kadoka Point, 1 (UMMZ); 7 mi. S Kadoka, 2 (UMMZ). Corral Draw, S. D., 7 (AMNH). **Texas:** *Armstrong Co.:* Washburn, 1 (USFWS). *Bailey Co.:* 9 mi. SW Muleshoe, 6 (UMMZ). *Brewster Co.:* Alpine, 1 (USFWS). *Briscoe Co.:* 6 mi. S Quitaque, 3 (UMMZ). *Hardeman Co.:* 0.25 mi. S Chilicothe, 1 (TCWC). *Hemphill Co.:* 6 mi. E Canadian, 1 (UMMZ). *Hockley Co.:* 2 mi. NE Ropes, 1 (UMMZ). *Howard Co.:* 6 mi. NE Coahoma, 6 (UMMZ). *Jeff Davis Co.:* Limpia Canyon, 10 mi. N Fort Davis, 2 (UMMZ). *Lubbock Co.:* 5 mi. N Lubbock, 1 (UMMZ). *Lipscomb Co.:* Mobeetie, 2 (USFWS). *Pecos Co.:* Fort Stockton, 1 (USFWS). *Presidio Co.:* Marfa, 1 (USFWS). *Ward Co.:* Monahans, 1 (USFWS). **Mexico:** *Chihuahua:* Casas Grandes, 4 (USFWS); Santa Rosalia, 1 (USFWS).

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GENERAL NOTES

THE SENSE OF SMELL IN THE SHORT-TAILED SHREW

Several observers of captive shrews have expressed the opinion that they do not find food by the sense of smell except at very short distances. P. H. Blossom (Jour. Mamm., vol. 13, p. 138, 1932) thought it doubtful whether the sense of smell is well developed in *Sorex cinereus cinereus*. W. J. Hamilton (Jour. Mamm., vol. 25, p. 7, 1944) expressed the opinion that *Cryptotis parva* depended more on a tactile sense than on smell. As early as 1844, J. T. Plummer (Amer. Jour. Sci. Arts, vol. 46, p. 241) came to the conclusion that *Blarina brevicauda brevicauda* could not detect food by smell at a distance greater than one-half of an inch. On the other hand, A. B. Klugh (Jour. Mamm., vol. 2, p. 35, 1921), after observing this species in the wild, thought that its food was found entirely by the sense of smell. One was seen to capture by jumping a sphinx larva suspended from a twig "a few inches above the ground."

While trapping for weasels, snap-traps were suspended perpendicularly from nails on the sides of stumps so that the bait, raw beef, would be a few inches above the snow. On the morning of December 29, 1945, I found a short-tailed shrew (*Blarina brevicauda brevicauda*) in one of the traps. The shrew had burrowed up through the snow, that was 7 inches deep, directly beneath the bait. Since the latter was 3 inches above the snow, it was necessary for the shrew to stand upon its hind legs in order to reach the bait. It would appear, therefore, that this species can discover food by scent at distances considerably greater than has been assumed.—A. W. Schorger, *168 N. Prospect., Madison 5, Wisconsin.*

BLUE JAY ATTACKS RED BATS

On June 9, 1946, across the street from my home in Fort Worth, Tarrant County, Texas, I observed an attack upon a family of red bats (*Lasiurus borealis*). It was about 1:30 p.m. when I noticed a blue jay (*Cyanocitta cristata*), hopping about near the curb. A curious hissing and squeaking came from its vicinity, and near the jay there appeared to be a large moth. I crossed the street to investigate, and discovered that what had seemed to be a moth was actually a red bat lying upon its back. Clinging to the mother was a baby bat about one-third grown, and three feet away, at the place where I had first seen the blue jay, was a second baby. The adult exhibited the usual fury of molested bats. I picked up the detached baby, thinking it was dead, but soon discovered that it was apparently uninjured. Closer examination of the other young one revealed a small, bleeding wound near the thumb. This may have been inflicted by the jay or by the mother in her slashes at the intruder.

The small bat that had been separated from its mother was restored to her, and all three were placed in a dense arbor vitae in my yard. Soon after being left alone the mother rearranged her young in their usual head-down position. Later in the afternoon she crept farther into the shade of the tree. From time to time the baby bats were observed nursing. At about 7:45 p.m. the female departed, leaving the uninjured baby behind. It was still alone at 10 o'clock, but had disappeared by 6 a.m. the following morning—presumably taken to some other retreat by its mother.

It seems likely that the young bats had grown to a size too great for the mother to support together in flight. The attack by the jay probably dislodged her from the sycamore tree beneath which they were found.

Of interest to me was the distinct difference in color of the two small bats. One was red, although of a deeper shade than I have ever observed in an adult of this species. The other was gray, with little if any hint of red.—Philip F. Allan, *Soil Conservation Service, Fort Worth 1, Texas.*

PORCUPINE SPINE PENETRATION

On July 7, 1944, a captive porcupine, Maudie, gave birth to a male which was found at 10:00 a.m. The animal was weighed, measured, observed and handled for the better part

of an hour. During that hour a quill about 15 mm long was stuck into the skin of the back of my right arm about four inches below the right elbow. Since it entered the skin almost parallel to the surface, the prick of the spine was not felt at the time and the spine was not discovered until more than seven hours later, after it had penetrated rather deeply and obliquely into the skin. Not knowing how deeply it was imbedded, two unsuccessful attempts were made with the thumb and finger to jerk it out. A pair of pliers slipped off the spine at first trial, and in the second trial broke the spine off about one millimeter from the point of entrance into the skin. I then went back to finish a job of painting that had to be finished while it was still daylight.

Three hours later, the piece of quill had completely disappeared and was already well under the surface of the skin. Due to the necessity of cutting into the arm to locate it, it was allowed to remain to see what would happen. Having come from a newborn young, the spine was apparently fairly clean for there was none of the aching sensation such as one frequently experiences from the penetration of an old soiled procupine spine. During the hours that the spine was in the arm, only occasional very slight pricking sensations were felt. Approximately 42 to 45 hours after it entered the skin, the sharp end emerged from the skin 42 mm from the point of entrance. A few hours later the broken spine projected through the skin far enough that it could be grasped by the thumbnail and forefinger and removed. The piece of spine had traveled 42 mm through the skin and muscle in a period of 42 to 45 hours. This would be at the rate of approximately one millimeter per hour or nearly an inch per day for this seven millimeter piece of spine.

Studies are now under way to make further determinations on the penetrations of flesh by procupine spines.—Albert R. Shadle, *Biology Department, University of Buffalo, Buffalo 14, New York.*

A NOTE ON THE PREDACEOUS HABIT OF THE WATER SHREW

Recently in Vernon Bailey's *Mammals of Oregon* I came upon the statement that the Rocky Mountain water shrew, *Sorex palustris navigator* (Baird), never has been convicted of being predatory upon fishes. The acquittal of the species is in these words:

> "They have been accused of eating salmon eggs and small fish, but apparently none of these charges has been proved by actual examination of stomach contents."

At the suggestion of Stanley G. Jewett, biologist, Fish and Wildlife Service, I prepared this account of the pursuit and capture of a salmon parr by a water shrew. From the locality in which this was observed, Mr. Jewett is of the opinion that the animal may have been *Sorex bendirii palmeri*, instead of *S.palustris navigator*, but there can be no least question of its aquatic habit and predatory nature. The specimen was not obtained.

Some years ago, in company with my son, the late Herbert Sheldon Lampman, I was fishing the lower reaches of the Sandy River, Multnomah County, Oregon. We were casting together when one of us observed a diminutive mouse-like animal approaching the water's edge. Instantly we stopped fishing to watch, and stood still. At the edge of the open river there was a small shallow pool in the gravel, with no more than a hand-span of entrance. In this pool a dozen or so of salmon parr were loitering. After a moment of reconnaissance, the water shrew—for so it soon identified itself—plunged into the pool and pursued the fish.

The shrew was as agile as any otter, both in swimming and in diving, and the frenzied alarm of the salmon parr was such that none of them escaped to the river. Yet they were not readily to be taken, and an appreciable length of time ensued before their pursuer made a capture. The water shrew, its prize in its mouth, then swam to a flat rock at the margin, upon which it crept, and seemed consciously to pose there, with the shining two and one-half inch long fish held securely at the middle. Of a sudden it took alarm, and quitted the rock to disappear in the grasses of the river brink, carrying its prey in its mouth.—Ben Hur Lampman, *The Oregonian, Portland, Oregon.*

NOTES ON REPRODUCTION OF PEROMYSCUS EREMICUS IN A LABORATORY COLONY

From 1941 to 1943, a colony of *Peromyscus eremicus* was successfully maintained at the laboratories of the National Institute of Health, Bethesda, Maryland, for use as experimen-

tal mammalian hosts of *Trypanosoma cruzi*, the protozoon causing American trypanosomiasis (Chagas' disease). A record of the breeding experience of 66 female mice was kept individually and forms the basis of these notes concerning size of litters, interval between litters, and the age at first pregnancy.

The original group of mice was obtained from the University of Arizona, Tucson, Arizona, and was reidentified by Vernon Bailey. Each female was numbered and kept with a male in a separate wire cage about 45 x 30 x 30 cm in size. The mice were fed rat pellets prepared according to specifications of the National Institute of Health laboratory supplemented three times a week with bread, milk, lettuce and once a week with fresh meat. Water was always available to the animals and cotton was supplied for nesting material.

Although several species of *Peromyscus* have been kept in captivity, little has been recorded about the habits of *Peromyscus eremicus*. Svihla (Univ. Michigan Mus. Zool., Misc. Publ. no. 24, pp. 1–39, 1932) found that five litters averaged 2.6 per litter and that the gestation period for one female was 21 days.

TABLE 1.—*Size of consecutive litters of P. eremicus*

LITTER ORDER	NO. LITTERS OBSERVED	MEAN NO. OF YOUNG PER LITTER	STANDARD DEVIATION
1	52	2.19	.809
2	49	2.47	1.231
3	44	2.32	.847
4	45	2.49	.957
5	40	2.80	1.166
6	34	2.88	1.180
7	32	2.63	1.111
8	28	2.61	.939
9	22	2.41	.937
10	21	2.62	1.214
11	17	2.18	1.248
12	13	2.46	.843
13	11	2.91	.899
14	6	2.50	1.256
15	6	1.83	1.047
16	5	1.60	.800
17	3	.75	—
18	3	2.00	—
19	2	2.00	—
20	0	—	—

In the colony here described 404 litters were recorded with a mean size of 2.42 individuals and a standard deviation of 0.95. The sizes of the consecutive litters of the females are shown in Table 1. No individual is included which had only one litter. From these data it is seen that the number of young per litter increased gradually till the fifth and sixth litter and then decreased. After the tenth litter the small numbers permit greater variations, but the decrease continues. A similarly shaped curve was found by King (Anat. Rec., vol. 11, pp. 269–287, 1916) for the albino rat, but the maximum occurred at the second litter

The young females were placed with the males as soon as fullgrown, but many did not breed for several months. Indeed the average age at first litter was 10 months, although some began breeding at 3 or 4 months of age. Possibly unfavorable surroundings or unsuitable males were responsible for lack of pregnancy till an advanced age.

On the average, the mice had a litter every 50 days. However, the individual females had several litters at intervals of 28 to 30 days and then rested for several months.

The sex ratio in 41 litters was 64 males to 57 females, or 112 males to 100 females.—DAVID E. DAVIS and DORLAND J. DAVIS, *Johns Hopkins University, Baltimore, Maryland, and U. S. Public Health Service, Bethesda, Maryland.*

FLORIDA OTTERS EAT LARGE TERRAPIN

On September 1, 1941, southwest of Orlando at Windermere on the shore of Lake Butler, Orange County, Florida, the writer observed a group of Florida otters (*Lutra canadensis vaga* Bangs) feeding on a large terrapin (*Pseudemys* sp.) at least 15 inches in length. The observation took place shortly after 1:00 p.m. while the writer was concealed in a boat house about 30 feet away from the scene of action. There is a short canal leading from the shore of the lake to the boat house, and on one side of the canal is a marsh and scattered cypress trees. An otter was noticed dragging a large terrapin by one of its hind legs from the canal to the bank at the edge of the marsh; immediately, another otter came out of the marsh and the two of them began eating it. Shortly after, however, another appeared and still another, until there were four of them feeding on the terrapin.

They soon made short work of the reptile; the legs and head were first torn out and eaten and then the viscera. An amusing incident occurred when one of the otters lay on his back with his eyes closed and ate a chunk of meat by holding it in his paws, apparently in perfect contentment. They occasionally made noises like fighting cats and fought over the meat, but on the whole were peaceable and each bent on eating his portion and not interfering with his fellows. Occasionally, one would stop eating and look around. They reminded one of huge snakes as they worked about on their prey, their black bodies glistening in the sun like polished ebony. The animals were watched for about 30 minutes until they were accidentally frightened into the marsh. They dragged the remainder of the terrapin with them and continued to feed on it there. The otters were apparently young of the year and looked to be about two-thirds grown.

On September 8, a group of five otters was seen and approached to within four or five feet; they made soft whining noises similar to puppies. One of the animals was larger than the others and was undoubtedly the mother. Since they were seen near the same place as the first group, they were probably the same family.

On Lake Butler, the writer counted the heads of 90 terrapins protruding above the surface of the water in one small area. With the abundance of terrapins in this and other Florida lakes, otters have an abundant food supply of these reptiles.—JOHN J. STOPHLET, *The Baker Sanctuary, Bellevue, Michigan.*

FIRST RECORD OF CHOERONYCTERIS MEXICANA IN CALIFORNIA

Five specimens of the long-tongued bat *Choeronycteris mexicana* (Tschudi) were collected by the writer on September 18, 1946, in a garage on Hermosa Way, San Diego, California. Although this is the first California record of this species it is not particularly surprising to find it in southern California as it occurs in adjacent Arizona, and in Lower California and Sonora, Mexico.

The collection site was a two-car wooden garage on the Mission Valley edge of Mission Hills, a long established residential section of San Diego. When the garage was entered at 5:15 p.m. September 18, 1946, the five bats (two male and three female) were found hanging from the 2 x 4 rafters of a dark corner. They were closely huddled in two groups of two and three about ten inches apart. At the first approach of the insect net all of these seemingly wary bats took flight and were subsequently netted individually. Two were caught while in flight and three from their hanging positions which were assumed after a short period of undisturbed flight within the garage. The owner of the garage first recognized these animals as bats on September 13, 1946. He said they may previously have been mistaken for birds as they took wing when they were disturbed by someone entering the garage.

Additional collections of these bats have come as the result of newspaper articles calling attention to the presence of new bats in San Diego. A "mummified" male was collected

on September 26, 1946, from its hanging position on a roll of canvas in the basement of a home on Arcadia Drive. This site is one-half mile from the first collection and also borders on Mission Valley. It was first observed on September 19, 1946, by a plumber who reported it still quite flexible at that time. Other records in the notes of the writer show these bats more than 3½ miles from the first site. A female was collected in a garage on Central Avenue on September 27, 1946, and another was collected in the Cypress View Mausoleum on October 8, 1946. One other was positively identified in the basement of a frame house on Vancouver Street, but escaped capture. When approached, the bat took flight from its hanging position on the rafters and escaped through a latticework. This was at 10:30 a.m. on October 1, 1946. The owner of the property reported that the bat, one of four previously seen by her, returned later that day but was not seen on subsequent days. Mr. L. M. Huey of the San Diego Natural History Museum has similar scattered records as the result of the newspaper articles.

Although these bats appeared to be in perfect physical condition they were short lived in captivity. Two of the first five died within 24 hours under conditions similar to those in which I have kept other genera for at least three days. Two of the bats kept in cages and supplied with a generous supply of food lived four days. In adjacent cages bats of the genera *Myotis*, *Corynorhinus* and *Antrozous* lived successfully on their insect diets. The long-tongued bats were fed grapes and plums which had been crushed so as to free the juice. This juice was lapped up by the long tongue as it was thrust out, sometimes more than an inch, over and around the crushed fruit. Feeding took place while the bats were loosely hand held and also voluntarily from a shallow dish on the cage bottom. Solid material was not accepted and no attempt at chewing was observed. Solid portions of fruit brought into the mouth by the tongue were pushed out of the mouth.

While collecting and handling these bats the writer was bitten on both hands at least four times between September 18 and September 28. On September 30, cellulitis and lymphangitis had developed in my right arm. This responded to penicillin and sulfadiazine treatment which was discontinued October 4. Three days later, I awoke with a severe headache which would not respond to antipyretics. This was followed by nausea and a sudden rise in temperature. Relief came after four days in a hospital with penicillin, morphine, ice packs on head and intra-venous injections of saline and glucose. It is impossible to be certain that this infection came as the result of the bat bites but there was no other apparent source.

Acknowledgement is made to Dr. S. B. Benson, Museum of Vertebrate Zoology, University of California, Berkeley, California, for the identification of the specimens.—ANDREW C. OLSON, JR., *Biology Department, San Diego State College, San Diego, California.*

A SECOND FLORIDA RECORD OF MESOPLODON EUROPÆUS

On January 1, 1944, while serving with the United States Army at Fort McPherson, Atlanta, Georgia, I visited St. Augustine, Florida. In the patio of the Don Toledo House, a historic structure on Aviles Street much visited by tourists, I noticed the weathered skull of a beaked whale of the genus *Mesoplodon*. With the aid of my wife, I secured a photograph and measurements of this unusual specimen, which I believe to be Gervais' Whale (*Mesoplodon europaeus*).

Through the kindness of Dr. Remington Kellogg and Mr. H. Harold Shamel, of the Division of Mammals, United States National Museum, Washington, D. C., I have been able to compare my photograph with the skull of the young male *Mesoplodon europaeus* collected at Atlantic City, N. J., in 1889. The two skulls are similar in many respects. They agree in having the mesirostral groove unossified. Unfortunately, the mandible of the St. Augustine specimen was missing.

According to several residents of St. Augustine who were questioned, the skull at the Don Toledo House came from one of three whales that were washed onto St. Augustine Beach "about twenty years ago." St. Augustine Beach is on the outer shore of Anastasia Island, which lies across Matanzas Bay from the city of St. Augustine.

Mesoplodon europaeus is one of the rarest mammals extant today. Apparently the St.

Augustine skull is the fifth example of this cetacean to be recorded. For many years, the type was unique. The four specimens which have come to light since then have all been found in American waters, making Gervais' specific name, *europaeus*, seem rather inappropriate.

Comparative measurements of the known skulls of *Mesoplodon europaeus* are listed below.

	ENGLISH CHANNEL (TYPE)[1] MUS. CAEN, FRANCE ♂ ? ADULT 1840	ATLANTIC CITY, N. J. U.S.N.M. 23346 ♂ YOUNG 1889	ROCKAWAY BEACH, N. Y. A.M.N.H. 90051 ♀ 1933	MIDDLE KEY, FLA. A.M.N.H. 121894 1935	ST. AUGUSTINE, FLA. 1924 ?
Total length	765 mm	675 mm	780 mm	775 mm*	755 mm**
Tip of rostrum to rostral border of anterior nares	550		570	575*	562**
Tip of rostrum to a line joining antero-lateral processes of maxillaries	430	427	460	465*	438**
Depth of rostrum at highest point of anterior palatine suture	77	40	64	70	76
Depth of rostrum at middle					57
Greatest diameter of orifice of anterior nares	55	42	53	55	50
Greatest breadth of premaxillae proximally		142	158	151	157
Greatest width of skull	370		363	365	365
Breadth between orbits	——	287	330	320	338

[1] The measurements of the first four specimens are taken from H. C. Raven, Amer. Mus. Nov., no. 905, 1937.

* 75 mm has been added to this measurement as approximately that much of the rostrum is missing.

** Tip of rostrum is missing.

At the time of my visit in January 1944, the Don Toledo House was owned by the St. Joseph's Academy, 241 St. George Street, St. Augustine. My arguments that the skull belonged in a museum were to no avail, for the Mother Superior of St. Joseph's Academy was quite emphatic in stating that the skull must remain where it was.

It is my desire to make known to mammalogists in general, and cetologists in particular, the existence of this rare specimen. I hope that someone will be successful in placing the skull in a natural history museum, where it will be safe from the vagaries of the elements.

FREDERICK A. ULMER, JR., *Zoological Society of Philadelphia, Philadelphia, Pennsylvania.*

GRAY EASTERN CHIPMUNK IN NEBRASKA

The eastern chipmunk *Tamias striatus* referred to in this journal (vol. 24, no. 2, pp. 273, June 8, 1943) has been examined by Dr. G. H. H. Tate of the American Museum of Natural History and identified as a specimen belonging to the subspecies *griseus*.

There are three reliable sight records of the gray eastern chipmunk in the Fontenelle Forest Reserve, a track of virgin timber along the Missouri River about two miles south of Omaha, Sarpy County. The late Professor M. H. Swenk saw a chipmunk in the Reserve on the occasion of the 28th annual field day of the Nebraska Ornithologists' Union on May 17, 1930. Another well established sight record is that of Dr. Harold Gifford, an official of the Fontenelle Forest Association, who writes that, "I personally have seen the eastern (gray) chipmunk in only one place in the forest, that being on a little rise of ground just before the river trail drops into Child's Hollow. The years that I saw this chipmunk were

probably 1934 and 1936." A chipmunk was seen by the writer in the spring of 1936 near the northern border of the Reserve close to the railroad tracks. The animal allowed the writer to approach within a few feet thus making the identification positive.

Two additional specimens besides the mounted animal in the writer's possession, are known to have been taken in the Reserve. These specimens were taken in 1930 and mounted by a local taxidermist, but have long since disappeared. Local residents and trappers report that the chipmunk has not been seen or taken in recent years.—RALPH VELICH, *5212 South 23 Street, Omaha, Nebraska.*

EFFECTIVENESS OF LIVE TRAPS VERSUS SNAP TRAPS

When collecting small mammals in the last week of August and the first part of September 1946 at four localities in southern Wyoming, I used 28 live traps loaned by Dr. G. C. Rinker. To compare the effectiveness of these with snap-traps (museum specials), a snap trap was set alongside each of the live traps. A mixture of oatmeal and peanut butter was used as bait on both kinds of traps. The live traps were approximately 8″ x 3″ x 3″. They were constructed according to the plan described by Blair (Jour. Wildlife Mgt., vol. 5, p. 191, 1941) except that the outside was made of ½-inch wire mesh; only the treadle and door were solid sheets of metal. The following table summarizes the results.

	TRAP DAYS		TRAP NIGHTS		TOTALS	TOTALS
	Live	Snap	Live	Snap	Caught in live traps	Caught in snap traps
	186	183	236	230		
Sorex	2	—	—	4	2	4
Sorex palustris	—	—	1	—	1	0
Citellus lateralis	—	1	—	—	0	1
Eutamias minimus	13	5	—	—	13	5
Peromyscus	—	—	27	18	27	18
Clethrionomys	2	—	5	1	7	1
Microtus	4	1	30	11	34	12
Lagurus	—	—	1	—	1	0
Zapus	—	—	1	1	1	1
Totals	21	7	65	35	86	42

As shown in the table, the live traps caught at night almost twice as many animals as the snap traps and in the day caught three times as many.—E. LENDELL COCKRUM, *Museum of Natural History, University of Kansas, Lawrence, Kansas.*

CANADA LYNX TAKEN IN SAUK COUNTY, WISCONSIN

On May 31, 1946, Harry G. Anderson, of the Wisconsin Conservation Department, informed me that a lynx (*Lynx canadensis canadensis*) had just been presented for bounty. It was shot by Peter Schrofer on May 29 in the Wisconsin River bottoms in Sauk County, Wisconsin, 5 miles east of Spring Green. It was an adult male with the following measurements: length from last tail vertebra to end of nose 38.5 in.; hind foot 9.5 in.; height at shoulders 23.75 in.; ear tufts 1.9 in. The animal weighed 27 pounds when shot. It was purchased and donated to the Department of Zoology, University of Wisconsin.

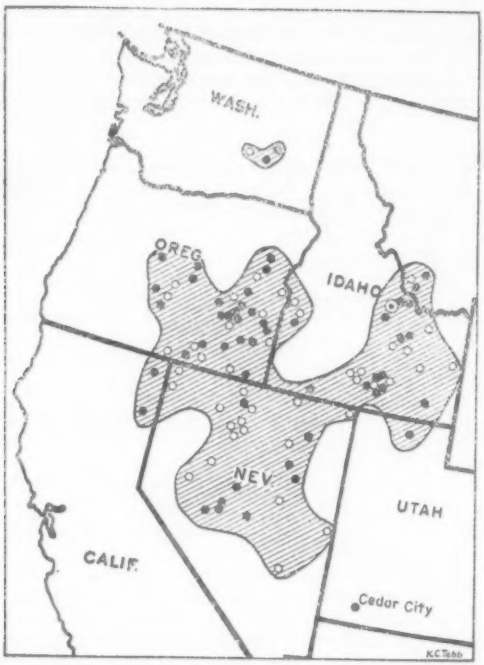
Hunters stated that this lynx had been in the vicinity for two years and had injured their dogs on several occasions. Occurrence so far south is surprising since there has been no other record for the state for many years. While at Tenderfoot Lake, Vilas County, Wisconsin, in October, 1943, I secured a bobcat from Joseph E. Fischer. He informed me that he had never caught or seen a lynx during 35 years of professional trapping in northern Wisconsin and the Upper Peninsula of Michigan.

The last previous occurrence of the lynx in southern Wisconsin was in 1907. On June 15,

1936, I made the following note: "While at Aldo Leopold's cabin on the Wisconsin today, Herbert Stoddard told me that in 1907 he assisted Ed Ochsner in mounting a lynx that was shot near Prairie du Sac. The animal was very thin. Ed Ochsner came in later and stated that it was taken at Middleton [Dane County]."—A. W. SCHORGER, *168 N. Prospect Ave., Madison, Wisconsin.*

EXTENSION OF THE RANGE OF BRACHYLAGUS IDAHOENSIS

While recently identifying some U. S. Biological Surveys Collection specimens of the Idaho pigmy rabbit from near Cedar City, Iron County, Utah, I noticed this to be an exten-



Geographic range of Brachylagus idahoensis
◉=Type locality ●= Specimen
○=Literature record of occurrence

sion of range in Utah of approximately 270 miles farther south than previously recorded specimens from Promontory, Boxelder County, Utah (Stanford, Journ. Mamm., vol. 13, p. 79, 1932). It also extends the southernmost range of this species, the previous one (Hall, E. R., Mammals of Nevada, 1946) in Nevada being approximately the 38° latitude, while the Cedar City, Utah, record is 37° 25′. Our Nevada records include two localities extending the range in southwestern Nevada beyond those given by Hall, which are in Churchill County: Fallon, and 35 miles south of Lovelock.

The three Cedar City, Utah, specimens were collected by Reuel Janson, one on September 20, 1938, and the other two on December 28, 1938. The one taken in September has a pinkish drab pelage which appears to be molting, and the other two specimens collected in December have the winter brownish-gray pelage with the gray color predominating.

The map of the geographic range of *Brachylagus idahoensis* indicates the records and specimens collected in this range extending into seven States: Washington, Oregon, Idaho, Montana, California, Nevada, and Utah; and from 37.25° to the 47° latitude, and from 111° 20′ to the 121° 10′ longitude. This range is apparently confined to the Upper Austral and Transition life zones; and mostly in the Artemisian Biotic Province, excepting for the Washington specimens, which would be in the Palusian Biotic Province, and the Montana specimens in the Montanian Biotic Province (Dice).—VIOLA S. SCHANTZ, *Fish and Wildlife Service, U. S. Department of the Interior, Washington, D. C.*

ENTRANCE AND MIGRATION OF THE NORWAY RAT INTO MONTANA[1]

Montana has been the last state to succumb to the invasion of the Norway rat (*Rattus norvegicus*). Introduced several times in the early history of the state, apparently by common carrier, it usually either failed to establish itself or was decimated by control measures. The first successful establishment, according to Cates (1937), was at Lewistown sometime between 1920 and 1925, and by 1936 had spread through most of Fergus County. Davis

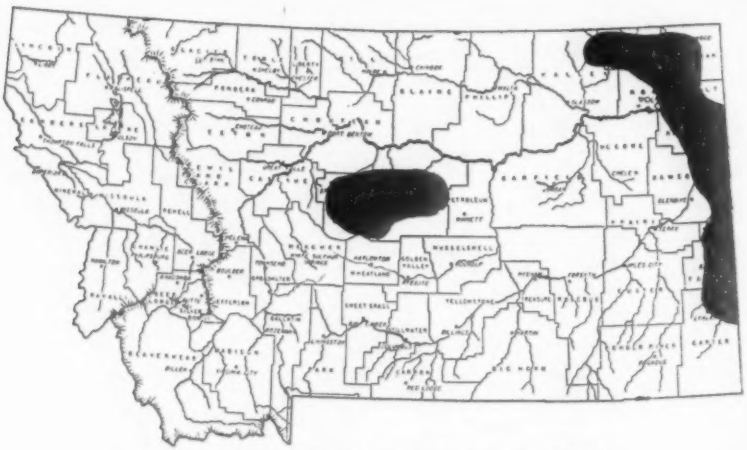


FIG. 1.—Distribution of the Norway rat in Montana

(1937) reported a specimen of this rodent from Lewistown in a collection of mammals from Montana and Idaho. Minckler and Pease (1938) reported a colony of albino rats that had become established in the city dump ground at Missoula, apparently from escaped laboratory stock. These were exterminated by poisoning. The above are the only direct references to the presence of the rat in Montana that the writer has been able to find.

At the present time the rat in the central part of Montana is found in much of Judith Basin as well as in Fergus County. In 1936 it also entered the state near Sidney and has since spread into or through the counties of Daniels, Sheridan, Roosevelt, Richland, Dawson, Wibaux, Fallon, and Carter. The map shows the approximate distribution in the State at the present time.

Both infestations are in the Great Plains area. The rate of migration is not rapid but it is relatively faster in the eastern part of the state than in the central. The Lewistown infestation has taken 25 years to spread over half as much territory as the Sidney infestation

[1] Contribution from the Montana State College Agricultural Experiment Station. Paper No. 184, Journal Series.

has covered in 10 years. This is probably due to the fact that the latter infestation is developing from an abundant base population in North Dakota and the former from a small original population. In both cases the extension of range has followed either highways or railroads and is thus confined mostly to the valleys.

In general, it appears that rats find extension of their range difficult in Montana and that in all likehood this difficulty is due to the sparseness of human population. The 1940 census records only 2.3 people per square mile in the rural areas of Montana. The greater part of the habitations of these people are confined to cities and to the valley bottoms in the infested areas; hence, the rats are likewise confined. In spite of this, by building up strong populations as they advance, rats are apparently capable of spreading across the entire state.

The present situation of the Norway rat in Montana should be a challenge to agencies interested in rat ecology and control, not only to study the advance of this rodent under different environmental conditions, but perhaps also to determine if rats can be halted in an area where the situation appears to be marginal for them.

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CLARENCE ARCHER TRYON, JR., *Department of Zoology and Entomology, Montana Agricultural Experiment Station, Bozeman, Montana.*

NOTES ON SOME MAMMALS OF HANCOCK COUNTY, OHIO

Citellus tridecemlineatus tridecemlineatus (Mitchill).—On June 28th, 1946, I saw a large specimen of the thirteen-striped ground squirrel running along a railroad embankment in the small settlement of Blue Pidgeon, located 3 miles southwest of Findlay, Ohio. To my knowledge this is the first report of this species in Hancock County.

Marmota monax monax (Linnaeus).—On Nov. 29, 1946, while on a pheasant hunt southeast of Findlay, Ohio, I surprised a large groundhog crossing a roadway. When it saw me the animal scuttled up over an embankment that flanked the road and crashed head-on into a wire fence, becoming momentarily entangled. This slight delay in its retreat gave me a chance to collect it. The specimen was a male weighing 8 pounds 11 ounces. Its total length was 25¼ inches; tail vertebrae, 6 inches; hind foot, 3.75 inches. The maximum temperature on Nov. 29 was 43°F.; the minimum, 32°. On the day preceding the maximum temperature had been 48°; the minimum, 22°. The animal was in excellent condition, without external parasites, and with an ample supply of fat. The fat on nearly all parts of the hide was a quarter of an inch thick and in the posteroventral region was five-eighths of an inch in thickness.

Peromyscus leucopus noveboracensis (Fischer).—On Nov. 22, 1946, I was emptying a line of bluebird nesting boxes two miles east of Findlay, Ohio. Upon removing the top from a nesting box located just within the border of a rather thickly-wooded area three mature northern white-footed mice leaped out and disappeared among the leaves. The nest that they had constructed was worthy of note. The deserted bluebirds' nest had been used as a base and had been left unaltered. However, a domed roof composed of small twigs averaging 3 cm in length had been constructed over it. Intermingled with this roofing material were upwards of 100 bits of wool. The quantity of wool used in this nest is not readily come by in a woods that has never been pastured. A search of the area finally disclosed five dead, half-grown lambs at a distance of about 130 feet from the nesting box. These must have been the source of the wool used in the nest.

During the winter of 1945–1946 one of my students, Leroy Barkimer, collected 85 pellets of the barn owl, *Tyto alba pratincola*, from a barn 3 miles southwest of Findlay, Ohio. When soaked in water and teased apart, these were found to contain a total of 227 skulls of various mammals and birds. There were five skulls of the Norway rat, *Rattus norvegicus*; 8 of the English sparrow, *Passer domesticus domesticus*; 13 of shrews, *Sorex* sp.; 199 of the meadow mouse, *Microtus pennsylvanicus pennsylvanicus*; and 2 of the New York weasel, *Mustela frenata noveboracensis*. It has been reported that the great-horned owl, *Bubo virginianus virginianus*, captures weasels but I have seen no previous statement concerning the capture of this carnivore by the barn owl.—Richard Stuart Phillips, *Biology Department, Findlay Senior High School, Findlay, Ohio.*

THE TYPE LOCALITY OF SIGMODON MINIMUS GOLDMANI

A recent comparison of the data of the type specimen of *Sigmodon minimus goldmani* with the locality listed in Vernon Bailey's original description (Proc. Biol. Soc. Wash., vol. 26, p. 132, 1913) revealed an error in the latter. The type locality is listed by Bailey as "seven miles north of Palomas, New Mexico". G. S. Miller in North American Recent Mammals, p. 373, 1924, also repeats this error and in addition places the locality in Quay County which is also incorrect. In North American Fauna No. 53, Mammals of New Mexico, p. 170, 1931, Bailey repeats his previous error; his distribution map is correct.

The correct locality as determined from E. A. Goldman's field catalogue and the label on the type is seven miles north of Las Palomas (at Hot Springs), Sierra County, New Mexico. Since Hot Springs is the actual locality and the town is now more than fifteen times larger than Las Palomas, I consider the former to be the better choice. Since the days when Goldman collected there, Hot Springs has grown to be a town of importance with possibility of permanency.—Marshall C. Gardner, *Fish and Wildlife Service, U. S. Department of the Interior, Washington, D. C.*

CORRECTIONS

The discussion which appeared in the general notes section of the Journal of Mammalogy, vol. 23, no. 3, pp. 346–348, 1942, has several errors that I wish to correct herewith.

On page 347, 2nd. paragraph, 6th. line, 183 square feet should read 96 square feet and 0.4 per cent should read 0.2 per cent. In the same paragraph, line 7, the word "volume" should read "weight." On page 348, line 2, 3,605 square feet should read 1,854 square feet and 8.3 per cent should read 4.4 per cent. The word "volume" on line 3 should read "weight". In the 2nd. paragraph, line 10, 3,605 square feet should read 1,854 square feet. In the last paragraph, line 4, 1,867 per cent should read 1,831 per cent.

These corrections in no way change the conclusions of the study.—Helmut K. Buechner, *Texas Cooperative Wildlife Research Unit, College Station, Texas.*

REVIEWS

Linsdale, J. M. THE CALIFORNIA GROUND SQUIRREL pp. 475 + xi, 140 figs. in text. University of California Press, Berkeley and Los Angeles, 1946. Price $5.00.

This monograph is the result of a seven year field study of the ground squirrel at one locality, the Hastings Wildlife Reservation in Monterey County, California. Besides being a major field project of the author during this time, the study at various stages received major contributions from ten coöperating field zoologists, who gave it almost their full attention for months or years at a time; numerous specialists of the University of California and other institutions also contributed in various ways, and the study "received active aid from hundreds of persons." The resulting treatise is perhaps the most detailed ecological account of a mammalian species that has appeared to date.

The text is divided into the following chapters: Introduction, Habitat, Associated Vertebrate Animals, Communication, Mannerisms, Activity, Food, Diseases and Parasites, Reproduction, Numbers, Structure, Summary. Each of these chapters has a number of subtitles. As an example, "Mannerisms" are separately dealt with as Attitudes, Locomotion, Scratching, Wariness, Response to Trapping, Gregariousness, Play, Fighting, Temperament, Memory, and Sanitation. These topics are discussed with copious illustrations from the field notes of observers. For instance "Scratching" occupies 2½ pages citing numerous specific instances of squirrels that scratched, with the time, manner, and possible significance of the behavior observed.

The chapter on Structure is notable for the meticulousness with which the external anatomy and that of the digestive system are described and related to the life and habits of the animal. The chapter on Reproduction is the longest one (58 pages) and includes a most thorough description of the reproductive organs and the seasonal changes that occur in them. The accompanying account of sexual behavior carries the implication that pairing off of the sexes, for perhaps two-week intervals, occurs during the breeding season. This seems extremely improbable to the reviewer. Actual copulation is yet to be described, but the field notes on sexual behavior strongly suggest promiscuity.

There is inconsistency in the scopes of the several chapters. For example, the account of Associated Vertebrate Animals is limited geographically to the few acres on the Hastings Reservation where field observations were made, consisting of accounts by species of all those mammals, birds, reptiles and amphibians which were seen to forage in proximity of squirrels, to use their burrows, or to elicit reactions from them. Encounters of squirrels with a young skunk, and with a cottontail are recounted at length, but these and most of the other narrative field observations do not seem to indicate relationships of fundamental significance in the ecology of either species. For the coyote, however, 78 instances of predation on ground squirrels are recorded from 980 scats, and several observed instances of destruction of squirrels by wildcat, golden eagle, domestic cat, and dog are included. By way of contrast, the chapter on Diseases and Parasites contains an extensive account of plague, not found in the squirrel population of the Reservation, includes a review of plague literature from all parts of the world, and summarizes life histories of some insect vectors of plague which likewise were not found or studied first hand. The latter half of this chapter is an account of the occurrences of 27 kinds of protozoan, helminth, louse, flea, and tick parasites in squirrels examined at the Reservation.

The book owes its bulk to the inclusion of countless narrated incidents taken nearly verbatim from field notes, to illustrate each phase of squirrel ecology investigated. In these recorded incidents, behavior is often set forth in such detail that it is difficult for the reader to distinguish the significantly illustrative behavior from the routine tail flickings, scratching, sniffing, and changes of posture that characterize most squirrel activity. It is the impression of this reviewer that every narrative field record obtained was included in the publication, with no attempt to eliminate material of doubtful significance or which involved extensive replication. Each of the numerous observers whose field notes were used doubtless developed increasing insight and skill during the course of his career as a squirrel

watcher; observations recorded and the interpretations advanced seem to be of varying merit. The author has exercised his characteristic restraint and objectivity in abstaining from interpolating his own interpretations into the field notes of his collaborators; rather, he usually includes any tentative interpretation ventured at the time of recording. In some instances these may impress the reader as naïve. Illustrations may be drawn from the chapter on Associated Vertebrate Animals, in the 9 page account of the Pacific Rattlesnake. It consists mainly of field notes on a squirrel colony on days when snakes were glimpsed in the vicinity, but only one record of actual predation was obtained, through the finding of a young squirrel in a snake stomach. As an example of a dubious interpretation it is recorded that: "Two ground squirrels were seen to come out of holes known to contain rattlesnakes. They rubbed their eyes and recovered from suspected injuries within five to twenty seconds. The theory was advanced that some odor given off by the snakes had affected the squirrels' eyes." The significant behavior seemed to consist of general watchfulness, nervousness, "wigwagging" of the tail by squirrels that had seen the snake, and avoidance of the snake when it attempted to approach dangerously close. In describing the activities of a squirrel colony where a snake was known to be over a several day period, frequent mention is made of mysterious swishing sounds "like wind blowing through dry grass", or "which might have been made by the wings of a diving hawk . . . not seen", "like something moving through the grass, not like a rattler's buzz" "some bird 'whooshed' unseen over the plot", but the reader is not further enlightened as to its cause.

Vagueness of this sort is frequently noticeable. In the chapter on Communication, under the heading "Sounds" there is a seven page discussion of the voice as recorded on various dates by different observers, but there is no attempt to sum up or classify the entire range of vocal sounds recorded. It is evident that interpretations of different observers varied, and that the same calls are repeatedly described in somewhat different terms at different points in the discussion. The reader is left with no clear idea as to how many types of sounds are produced, or which of those described are modifications or variations of the others.

In the chapter on Food, foraging behavior is emphasized, and observations of squirrels feeding are listed by date under the species headings of the various food plants. There is little indication of the relative quantities of different foods taken, or of any possible effect of ground squirrels on the quantity or composition of the forage crop. However, it is emphasized that under protection of the land from grazing or cultivation conditions are brought about that are progressively more unfavorable to the maintenance of high squirrel populations, or even result in their total exclusion.

The work is copiously illustrated throughout. The numerous graphs and diagrams are notable for their simplicity and clarity. The many photographs mostly depict phases of the squirrel environment, but the animal itself is conspicuously absent from them, except in the frontispiece plate.

In summation, the general criticism may be justified that the great mass of detail, much of it seemingly not pertinent to the specific discussion, often obscures rather than clarifies, and that more concrete and definite conclusions should have been possible from a study so exhaustive. But the reviewer does not intend to disparage the value of this outstanding monograph, containing as it does a rich fund of new information which must of necessity be thoroughly studied by all those having to do with the control of this economically important ground squirrel.—HENRY S. FITCH.

Tokuda, Mitosi. A REVISED MONOGRAPH OF THE JAPANESE AND MANCHOU-KOREAN MURIDAE. Biogeographica (Trans. Biogeog. Soc. Japan), Tokyo, vol. 4, no. 1, pp. 1–155, figs. 88, pls. 9. December, 1941.

The outbreak of war in 1941 prevented American mammalogists from obtaining copies of Tokuda's monograph of the Muridae of the former Japanese Empire. Only a few copies have as yet reached this country. As the most recent and by far the most complete treatise on its subject, this contribution will be widely used in future years. Its geographical scope includes Manchuria, Korea, Formosa, the Riu Kiu and Kurile Islands, Sakhalin, and Micro-

nesia, as well as Japan proper. The term Muridae is used broadly to include cricetine, microtine, and murine rodents.

In a preliminary section, the author sets forth his ideas on the principles of variation and explains his concepts of the lower taxonomic categories. Though many readers may doubt the wisdom of synonymizing all intergrading continental races or of recognizing the "variety" as a minor taxonomic category below the rank of subspecies, they will find that the author presents his opinions clearly and illustrates them with numerous examples. The systematic section is based chiefly on Tokuda's personal collection, supplemented by material borrowed from other sources. The preponderance of specimens from the home islands of Japan explains the relatively cursory treatment given species from Manchuria and other outlying areas. The full descriptions, and especially the numerous and well executed line drawings of skulls, teeth, and feet, will be welcomed by workers who have struggled with perfunctory original descriptions of Asiatic murids.

There is much new material in this paper. The skull of the little known *Mus caroli* is adequately described and figured for the first time, and the characters of some of the Formosan rats and mice are finally revealed to those who cannot read Japanese. Two new genera and five new "varieties" are proposed; unfortunately one of the generic names is preoccupied. Temminck's early names of Japanese mammals are handled with more than usual confidence, as in using *molossinus* in preference to *bactrianus* or *wagneri* for the common *Mus* of eastern Asia, and in separating *tanezumi* and *erythronotus* as synonyms of *Rattus norvegicus* and *R. rattus* respectively. The accounts were prepared without the benefit of G. M. Allen's "Mammals of China and Mongolia" or of Ellerman's "Families and Genera of Living Rodents," and in certain instances Tokuda's intensive study of a smaller area seems to have produced more convincing systematic arrangements.

Mammalogists in this country attempting to identify specimens sent home by occupation troops will find that this contribution has materially simplified their task, in the most numerous and difficult family of mammals.—David H. Johnson.

RECENT LITERATURE

(Conducted by Gerrit S. Miller, Jr., Remington Kellogg, and Emma M. Charters)

[Reprints of this section may be purchased from the Corresponding Secretary]

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COMMENT AND NEWS

CALL FOR PAPERS FOR ANNUAL MEETING

In April, each member should have received an announcement of the Annual Meeting of the Society which is scheduled for August 24–27, 1947, at Higgins Lake, Michigan. It is made clear in the announcement that members expecting to attend must notify the Local Committee, W. H. Burt, Chairman, or the Corresponding Secretary before May 10 in order to be assured of accomodations at Higgins Lake. A call for papers was not included with the announcement, but will be sent in July to those members who have notified the Local Committee of intent to attend. The present call for papers is the only one which will be sent to all members.

A few accomodations may yet be available. Therefore, if you think that you may be on hand, notify the Local Committee at once. You can be assured of informative sessions in the genial atmosphere of a country club, or, if you choose, you can prowl the wilds. In either occupation you should have a pleasant, profitable time.

MAMMAL COLLECTION AT BOSTON UNIVERSITY

In view of the recent publication of a list of mammal collections in the *Journal of Mammalogy* (Doutt, Howell and Davis, August 1945), I should like to add the following data on the collection of Boston University, housed in the Department of Biology at 688 Boylston Street. The collection has a total of 248 specimens, all of them study skins, most of which are also represented by the skulls. The total is distributed by orders as follows: Insectivora 40; Chiroptera 7; Carnivora 5; Primates 3; Rodentia 187; Lagomorpha 6. The locality best represented is Maine. Nearly all of the collection is the gift of Dr. Leland C. Wyman of Boston University.—RALPH B. PRIDDY, *Department of Biology, Boston University, 688 Boylston Street, Boston, Massachusetts.*

JELLISON RETURNS TO HAMILTON, MONTANA

Dr. William L. Jellison, Parasitologist of the Rocky Mountain Spotted Fever Laboratory, U. S. Public Health Service, Hamilton, Montana, and long-time member of the Society of Mammalogists, has recently returned to duty after nearly 5 years in Army or overseas duty. War caught up with Jellison with a bang on December 8, 1941, at Lashio, Burma, where he was serving as malarial control officer with the Yunnan-Burma Railroad. By June 1942, he was in India with the U. S. Army Air Force, working on general tropical disease control. Later, he served with the U. S. Typhus Commission at the field laboratory at Myitkyina, Burma. Jellison returned to the States in December 1945 and soon was back at Hamilton, Montana. In September and early October 1946 he visited New York with other members of the U. S. Public Health Service to study the new rickettsial disease in apartment houses in New York City.

RESEARCH REQUEST

I am interested in obtaining reprints, copies of unpublished manuscripts and results or observations made in connection with the biological control of mosquitoes. I want to bring this information together in the form of annotated bibliographies.—J. B. GERBERICH *Dept. of Biological Science, Michigan State College, East Lansing, Michigan.*

HERSKOVITZ MOVES TO CHICAGO

Philip Herskovitz, who for several years has been engaged in a study of certain South American mammals joined the staff of the Chicago Natural History Museum March 1 as Assistant Curator of Mammals.

SUMMER FIELD RESEARCH

The recently organized (1946) Jackson Hole Wildlife Park is actively sponsoring research on free-ranging animals, game management and conservation and the first of a planned series of yearly Summer Research Programs will be initiated early in June of this year. Professor C. R. Carpenter of Pennsylvania State College has been appointed Coordinator of this year's program.

A library, weather station and collections of plant and animal specimens are being established at the Park headquarters, Moran, Wyoming, by the Director, James R. Simon.

The research programs involve the cooperation of the Wyoming Game and Fish Commission, the University of Wyoming, the University of Wisconsin, the University of Michigan, Pennsylvania State College, Swarthmore College and the New York Zoological Society.

Specific objectives of the Summer Research Programs are: 1. A survey of the fauna of the Wildlife Park and adjacent areas. 2. A survey of the flora of the Wildlife Park. 3. A study of human factors in their relationship to the over-all purposes of the program. 4. Preparation of photographic and descriptive material on the present status of the areas in and around the Wildlife Park.

Ten or twelve field workers will be engaged in the Wildlife Park research program during the summer, and their basic studies will serve as aids in future planning of Summer Research Programs.

In announcing the Summer Research Programs, Fairfield Osborn, President of the New York Zoological Society, said: "It is our strong hope that the Jackson Hole Wildlife Park will become a vigorous center of study on animal and plant life. The location is admirably suited for such a center. Toward these ends, the cooperation of interested persons and institutions is solicited.

SETS OF THE JOURNAL

Fred M. Dille, 822 Grand Avenue, Nogales, Arizona, has informed us that he has two nearly complete sets of the Journal of Mammalogy for disposal. Those of you who might be interested in procuring one of these sets might find it profitable to contact him.

OBITUARY NOTICES

William Edwin Saunders, 1861–1943

Canada suffered a great loss in the death of Dr. W. E. Saunders at London, Ontario, on June 28, 1943, at the age of 82. W. E. Saunders was born at London on August 16, 1861, and lived his whole life there. He attended London and Dundas schools, Trinity College School (Port Hope) and graduated with honors from the Philadelphia College of Pharmacy in 1883. He was the founder of the McIlwraith Ornithological Club in London in May, 1890, (prior to 1903 known as the "London Ornithological Section of the Entomological Society of Ontario"), a Fellow of the American Ornithologists' Union (since 1883), Secretary-Treasurer of the Entomological Society of Ontario (1887–1906), head since 1886 of the wholesale druggists' and physicians' supply business bearing his name in London (founded earlier by his father), professor of Practical Chemistry at the London Medical School from 1884 to 1889 (then an affiliate of the University of Western Ontario), active member (since 1902) and President of the Wilson Ornithological Club (1912–1913) and charter member (1919) and Director (1931–1943) of the American Society of Mammalogists. At one time, early in the present century, he was also secretary of the American Peony Society. At London he had been Parks Commissioner as well as Water Commissioner. The University of Western Ontario conferred the Honorary degree of LL.D. upon him in 1936 for his "outstanding contributions to society."

W. E. Saunders was a man of great personal charm with the ability to inspire even casual acquaintances with his own enthusiasm for natural history. He was an enthusiastic field naturalist and loved to "rough it" and sleep out in the open even at an advanced age. On field trips he never failed to set out a line of mammal traps. The next day he would prepare his specimens wherever the opportunity offered—on his knee, in a car or train, in hotel rooms or lobbies. To the interested spectators who gathered around he would give one of his charming talks on Nature. It was astonishing the number of people in whom he built a life-long interest in nature through such casual contacts.

His natural history collection dates from 1873 when he began to collect as a boy of 12. His generosity led him to distribute groups of specimens to schools and colleges throughout western Ontario. Large collections were presented to the University of Western Ontario, London, and to the National Museum of Canada during his lifetime. The bulk of his collection, however, was given to the Royal Ontario Museum of Zoology.

He was responsible for several "firsts" in Ontario mammals. Some of these were New York pipistrelle (Ottawa, 1890), Baird's mouse (Point Pelee, 1907), and Rafinesque twilight bat (Point Pelee, 1911). Hoary bats and red bats, which he took at London 1886 and 1887, respectively, and common moles he trapped at Point Pelee may also have been the "firsts" for Ontario.

Dean of Ontario field naturalists, competent scientist in many fields, writer-educator, Dr. Saunders's long life has left a rich heritage, although in his death we are immeasurably poorer.—E. C. Cross.

Walter C. Henderson

Walter Cleveland Henderson, Charter member of the American Society of Mammalogists and former assistant director of the Service until his retirement on November 30, 1942, because of ill health, died suddenly on January 1, 1947, at his home in St. Peterburg, Florida, at the age of 70. His wife, Mrs. Margaret Henderson, and son Fletcher, were with him at the time of his death.

Mr. Henderson was born in Chelsea, Mass., on July 6, 1876, the son of William I. and Margaret Robertson Henderson, and was educated in the Chelsea and Somerville public schools and in Boston University Law School from which he was graduated in 1903. He

entered the Federal Service in 1897 and was employed in the Customs Service of the Treasury Department until 1907, at which time he was appointed as a law clerk in the Forest Service of the Department of Agriculture. At a later date he became assistant to the Solicitor of the Department of Agriculture and on December 1, 1916, he was transferred to the former Bureau of Biological Survey as assistant chief. The better to qualify himself for his work, he pursued a course in biological sciences at George Washington University in Washington D. C. where he received an A.B. degree in 1926. In 1927 he was made associate chief of the Bureau of Biological Survey and upon the consolidation in 1940 of the Biological Survey with the Bureau of Fisheries to form the present Fish and Wildlife Service, he was made assistant director. At the time of his retirement in 1942, he had completed 45 years of government service.

Mr. Henderson was a member of several other scientific societies, among them the American Ornithologists' Union, American Forestry Association, National Conservation Association, Cooper Ornithological Club, Baird Ornithological Club, the National Geographic Society, and the Biological Society of Washington, D. C. He also was a member of the bar of the U. S. Supreme Court.

HERBERT HUTCHINSON BRIMLEY

It is with deep regret that we report the death of Mr. Herbert Hutchinson Brimley, charter member of the American Society of Mammalogy, on April 4, 1942. Mr. Brimley was long associated with the North Carolina State Museum, a division of the North Carolina Department of Agriculture, at Raleigh, with which he became affiliated first in 1884. At that time he mounted a group of salt water fishes for the museum to be displayed at the state exhibition. In 1895, Mr. Brimley was given charge of the museum, and served as Curator of Zoology until his death.

His contributions to the field of Mammalogy have been largely in the nature of reports on aquatic mammals. He was particularly interested in whales, porpoises, seals, and the rare manatee.

INDEX TO JOURNAL OF MAMMALOGY

NOW AVAILABLE

The index to the first 20 volumes, 1919–1939 inclusive, of this journal are now on sale. Paper covers, $2.50; cloth, $3.50.